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SIR MATTHEW DIGBY WYATT, F.S.A., F.R.S., &c.

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THE revival of manufacturing art, the development of English taste, and the growth of popular affection for the beautiful and true, dates from the enthusiasm which brought about the Great Exhibition of 1851. Prince Albert was induced to devote his practical mind in the prosecution of labours for which he was eminently qualified and which he discharged with most magnificent success. Royalty never won greater honours than the young consort of Her Majesty achieved on that occasion. The eminently practical faculty in his nature had its exercise on a new work, in connection with inexperienced agents, for an undefined purpose, on a scale of magnificence, with a stake of tremendous hazard, and, as we all know, crowned with success. England had attained a ripeness in the fallow time preceding, was thereby enabled to rise. At the given word of command, as if of divine call, Paxton, Fox, Owen Jones, Wyatt, Cole, Dilke, and many, many others, banded together; all of singularly independent idiosyncrasies, all of one purpose, which was to create in England an artistic power that should be so formed as to regulate the national taste for some generations. They succeeded. It has been our happiness to have spoken of most of those good men; and now that the grave has claimed another, it is a duty, and also a melancholy pleasure, to recite some of the many characteristics of Mr. Digby Wyatt. Envied he was; contemned he ought not to be; despised he could not be: whatever differences of opinion may exist or be created in reference to detail, there cannot be a question that should any attempt to impugn his right to a position in the history of popular artistic progress that few beside can claim or obtain, they would receive universal condemnation. There are many claimants for the coveted position of being unforgotten; and many will be disappointed in their hope; for they will be forgotten. Digby Wyatt was one whose life and character belong potentially to the age in which he lived and the circumstances by which he was surrounded; he also belongs to the age that is; because of the adoption or rejection of the ideas on various subjects he so unhesitatingly placed before the world. We will make a hurried but exact review of those events and applications.

Wyatt began life as an architect: Paxton began as a gardener, and Fox as a surgeon, Faraday as a bookbinder, and Dalton as a schoolmaster. Wyatt was placed in his brother's office as an architect's clerk at the age of sixteen, and in a year he won a prize from the Architectural Society, for the best Essay on Grecian Doric. This was in 1837. The turning point of his career occurred on his taking a continental tour for professional purposes; a tour which extended over two years, every hour of which seems to have been spent with most laudable industry and rewarded with success such as has seldom fallen to human lot. In fact, there were then two men of remarkable capacity, singularly adapted to meet the wants of the age in which they lived, whose names and history will be preserved and honoured increasingly by all who love the history of modern art and its application to popular progress. Those were Owen Jones and Digby Wyatt. France, Germany and Italy were ransacked by the latter of these men, and he came back with stores of knowledge he had derived from studying all the chief examples of art and the choicest specimens of ancient monuments of every kind, and with, what made him a prince in his own domain of knowledge, more than a thousand drawings, among which were a carefully finished series of special subjects, such as the wonderful mosaics of Sicily and Italy—the terra cottas of Italy, &c.

Such a man could not be hidden—we do not claim for him a rivalry with Michael Angelo, but none can question his claim to high distinction on the grounds of originality, research, and adaptation. Take for instance, the paper he read to the Society of Arts in Feb. 1847 on Mosaics, Past, Present and Future; it is simply a masterpiece. Architectural decoration received an impetus as well as a revival; men were taught the principles as well as the history of sacred art; an art that dominates in temples, churches and mansions; among men of all religions, all stages of civilisation, all varieties of social habit. The palace of Ahasuerus had its beds of gold and silver "upon a pavement of red, and blue, and white and black marble." Persia abounded in such examples, and from it the Greeks most probably were instructed, and thence the Romans under the twelve Cæsars. In a masterly way he takes up the subject and illustrates the point asserted. Mosaic has four varieties; two applied to pavements; two to mural art. Pavement is the oldest; it consists of small cubes of marble of three-quarters of an inch worked into geometrical figures in endless variety and intricacy. First, the colours were black and white; then came the red and blue, as seen at Pompeii, the Vatican, and Caracalla. The second is the thin slices of differently coloured marbles called "*Crusta*" cut into forms which in combination made regular geometric figures *artistic and not imitative*. Contrasts in form, vein, and colour in pleasing intricacy, characterised such true artistic work, and made every specimen a creation. The Pantheon and St. Peter's at Rome are examples; but the art dates a hundred years before Christ.

Then Mr. Wyatt explained the mural decoration described by Pliny as used in the baths of Agrippa, which consisted of an imitation of figures, fruits, ornaments, &c., composed of alumina, and metallic oxides for colouring; or sometimes of marbles or stone. Gold and glass were also used. He also spoke of the best variety, which was limited to the direct imitation of figures, ornaments, pictures, &c, in their true colours and shades by an artistic arrangement of small cubes of different coloured marbles; and for extreme brilliancy, others of glass or precious stones. These were used freely, for pavements, for walls, and for pictures or portable works.

Let us now take a glance of the history of progress, and in so doing we need not apologise. What has to be said of Sir Matthew Digby Wyatt hereafter takes its tone from his appropriate address to the Society of Arts. It told among sinners and saints; it told among vulgar and refined. Try to realize mentally—forgive the disassociate term—the condition of the people when those wondrous Mosaics were constructed; they had a beauty recognised by the rude: and now they have scarcely any attraction for the rude? When they were put together, the common people had an instinctive taste which common people now-a-days have lost. To redeem us from this Wyatt has greatly contributed. He has manifested the existence of a beauty that, having no ornament but art, can touch the affections and excite to higher life the nature of the humblest, and has revived throughout the nation a taste quite lost. The trading streets, the entrances to private dwellings, the halls of mansions, alike share with the cottager the beauty inaugurated thereby. Mr. Wyatt's ancestor patented a mode of imitating tesselated pavements by inlaying stone with coloured cements, and although from the unequal hardness the plan did not receive acceptance, the burnt clay inlaid with coloured cements being also tried only to fail, Mr. Blashfield, an intimate friend of the family, effected the desired result.

There is an importance attached to this subject which warrants a little delay in our sketch. Mr. Henry Thomas Hope of Deepdene, Dorking—than whom few men could be named more excellent in taste, public spirit, and enterprise—called on Blashfield to construct an elaborate Mosaic flooring, which he did in a style which excited general attention, and paved the way for those general improvements in the art of manufacturing and laying down ornamental pavements.

These improvements were; 1st, Encaustic Tiles, in the manufacture of which Messrs. Minton enthusiastically entered. The fictile material made into forms of about six inches square was in a soft state superficially impressed by metal dies containing a pattern in relief; and the indentation was filled up by clays of another colour: then it passed through the processes of baking and glazing. The next step must be attributed to Mr. Singer, who desired to produce a perfect imitation of the ancient tesselated work (Opus Tessalatum). To do this he required small cubes of one size, hardness, colour, and surface. He placed well worked clay in a machine of powerful levers and great pressure, and in the exudation obtained the sizes required. These were ultimately burnt and partially vitrified, making a material for the most beautiful tesselated pavement. The Reform Club hall-floor, and a part of Wilton Church are known to be excellent. Then 3. we have the porcelain, an invention of Mr. Prosser who firstly applied it to buttons, but who found in Mr. Blashfield a better market through his connection with Mintons. The flooring of the Hall of the Society of Arts is made of this.

Again apologising, we must quote what has been long absorbed, but is of useful quality. In ending his description of Mosaics, Mr. Wyatt said—and here is the character of the man in whose nature existed the united taste of beauty and form, architecture and decoration—"There are many," said he, "awakening to the consciousness that architecture must be no longer shorn of its fair proportions or parted from its companions, sculpture, painting, and the industrial arts, or come cold and poor, naked and unadorned."

"Mosaic can scarcely require demonstration in its applicability, but we recite the ways by which it can become an essential

element of decoration. Pavements, figures, dados, pilasters, pulpits, church furniture, reredos, staircases, fire-places, picture-frames, and articles of furniture, are susceptible of beautiful adornment. Its glowing colours will revive our drooping taste, and its imperishability will perpetuate the fact that England possesses and cherishes a decorative art more lasting than Compo." Thirty years have passed since these words were written, and any one who is qualified to observe the present position of art, and to notice the melancholy prospects existing at that time, will feel some emotions of gratitude and admiration on hearing the name and knowing the work of Digby Wyatt.

A characteristic feature in this gifted individual is the determinative manner in which he insisted on the union of idea and utility. The highest standards of artistic excellence were not too high for his judgment and imitation; but he gloried in the faculty of making those transcendental thoughts applicable to the common service. It was in 1866, after a career of great renown, of which we shall have to speak hereafter, he addressed the Architectural Association, and urged on the noviciates the importance of being ready to seize upon any new invention or discovery, any new materials, or processes, or revivals of ancient processes, or disused materials, and introduce them into modern buildings, in order to give a character to the architecture of the age in conformity with the practical character which marks our age. New styles were not desirable; young men should transfuse all knowledge into an exemplification of the times in which they lived. New materials would give novelty and character. The industrial arts and the architect are naturally connected. Architects must in these days take great interest in manufactures, in chemistry, in novel combinations of matter. His own career exemplified his teaching. The mosaics of his young days had become the universal favourite; and wall-surfaces must follow in the same direction, ultimately changing the whole face of domestic and ecclesiastical architecture. He pointed out how colour had been increasingly adopted. Stained glass and the rich designs newly created imposed on the architect the necessity for efforts to make the buildings worthy of the windows. The mason had been obliged to employ colour, and the potter had by his tile-making created a new world of beauty and a new style of decoration. Pugin, who was the chief designer of the Houses of Parliament, made himself acquainted with all the best stone-carving, all metal work, all wood work. all stained glass, encaustic tile-designing, hangings, carpets, paperings, in order to evolve the grand idea committed to his genius.

In enforcing this thesis he illustrated the necessity for acquiring universal knowledge, by showing that if a man had the faculty for designing he could design anything; if he had the faculty for construction, there could be no limit to its exercise. But the design must be in harmony with utility, and so must be the construction. A box must not be like a book or a house, and a house must not be like a church. Beauty and taste are a necessary combination in the case of all good workers, but beauty and taste can only be acquired by careful studies in connection with the industrial arts. They must be under the control of utility: "An architect's duty was to create beautiful things, large or small—cheap for the million, and sumptuous for the millionaire, and he ought not to turn away from the manufacture of any ordinary objects on which the stamp of beauty could be impressed. Great architects are not only artists in their particular branch, but artists in the industrial branches." Many of the ancient architects were universal in their power of design; and in these times a good emolument can be derived from designing industrial objects, as manufacturers are constantly looking out for intelligence—not draughtsmen and modellers merely, but artists with knowledge, taste, and talent. It should be the pride of all those whose occupations led them to deal with matters of beauty to endeavour to advance the industries of the country, and to aid in developing art in every way. The British architect's aim should be perfection, just as was the Greek's. Everything was perfect—from the Parthenon to a necklace, from the philosophy of Plato to the gem he might have worn upon his little finger. With a high eulogism on Pugin, as worthy of study for the sake of his example, he brought a valuable lecture to its termination amid the applause of the company.

It is not possible to extol excessively the labour and service of Wyatt and Owen Jones in connection with the Great Exhibition, the Crystal Palace, or the amazing results. On returning from his Continental tour, the Council of the Society of Arts desired him to report on what he had observed in the eleventh French "Exposition of the Products of Industry," and he complied by giving a history of the structure erected, an account of the history of the foundation, &c., and observations various.

Mr. Wyatt approved of the site, but not of the arrangements. There had been a culpable neglect in classification, which neglect enhanced the labour of all who attempted study. The object of exhibitions, he contended, should be to instruct the public; and unless perfect classification existed the impressions derived from inspection could not be created. All the labour of observation would be lost, and nothing but a sense of weariness remain. M. Dupin had taught, in 1834, the best system, but his analysis was not adhered to. He wisely established a system of division, based on the relation of the arts to man; which is the only method of conveying knowledge by the agency of such collections.

The commercial crises of that period (1848 *ad sup.*) were hurtful to progess, but every subsequent year gave forth a progressive tale of advancement, despite all allowances caused by political follies. France, even in that troubled time, remained the queen of taste, and the education of her workpeople retained the charm and enthusiasm which gratified her people and the world. But France had no idea of manipulation in mechanics on anything like a scale corresponding to the position of a great country. What was gutta-percha, tin-plate, Britannia metal working to her? What could she do to face Doulton and Coupland in earthenware, or how could she do anything to cheapen production through machinery, to throw open to the world the blessings of novel productions created through modern art or the revival of ancient ways? France could invent or apply arts or machines, but, having no mechanical resources in comparison with her artistic faculty, she must remain unable to command the market open to England; but, as the race was free, it became both nations to do their best in their several ways.

The French Exposition in 1849 excelled all that had preceded; and Napoleon devoted all his strength to make it successful. He spent national finances in a manner that no English Treasury would have borne, and he took especial interest in the selection of the specimens exhibited. Wyatt reported that the education of French artisans to the utmost capacity, was manifest everywhere; he could seldom find bad ornamental modelling, and the drawing was fine. The example thus set brought fruit here. It was the parent of the Great Exhibition. He came home to teach from what he had seen, in praise and in defect, how an exhibition should go on; how its catalogue should be framed; how the articles should be arranged; how the exhibition should be guided; what were the proper conditions for a structure; and what should be the standard principle in selection. After all these had been discussed, and the arrangements duly praised, he closed his report thus:—"One peculiarity, which architecturally was most distressing, was that a system of *sham* seemed to preside over all the ornaments and construction. Great *carton pierre* trusses which supported nothing, painted bas-reliefs to imitate bronze, fir covered all over with paper to make it look like oak, were all unnecessary and wasteful professional forgeries. If each simple material had been allowed to tell its own tale, the qualities of power and truth would have excited admiration, and at little cost." "We believe," said he, "that a better building can be erected, affording the same area and advantages, and avoiding its defects, for a fourth of the money."

England determined to eschew negligence or cowardice, and resolved on offering mankind a world's display in consequence of this appeal, supported as it was by the tendency of the age and the spirit of the people. Mr. Wyatt received instructions from the Society of Arts to make preliminary inquiries of manufacturers concerning their willingness to support periodical exhibitions of works of industry; and several other coadjutors were included. Meetings were held in almost every town, and the scheme received a welcome which surprised its promoters. The best men in every district vied with each other, and combined to produce a magnificent success. There have been many exhibitions, but that of 1851 stands the most conspicuous example as to quality and effect. In the biographies of Sir Joseph Paxton and Sir Charles Fox the building has been described in this journal, and repetition is not necessary. The principles Mr. Wyatt propounded are, however, another matter; they had reference to other departments, and had a distinctive object and purpose; contributing to a common end, but quite independent in their action and expression; especially was this the case in one instance, that of Mr. I. K. Brunel, who, it may be remembered, produced a design for an exhibition building which did not obtain favour, and Sir Joseph Paxton's did. Wyatt and Jones belonged to Sir Joseph's school; their styles and ideas admirably consorted; but the friendship with Mr. Brunel remained unimpaired, and brought him the architect's office for the erection of the Great Western Railway at Paddington. He also restored the fine chancel of North Marston Church for the Queen, as a memorial to the late Mr. Neild, who

had made her a great bequest. He also designed a stained glass window to the memory of Mr. Huskisson, in Chichester Cathedral; a mausoleum for the Baroness de Rothschild; Italian gardens at Castle Ashby; several mansions in various places; the memorial arch at Chatham; several important buildings for the Indian Office in England and in that Empire; jointly with Mr. Scott the new Indian Office in Downing Street; and in connection with his brother the barracks for cavalry. The bare enumeration would extend over too much space; we have named a few to show his varied powers.

In literature his contributions are also too numerous for description, and they were all of the best character. The magnificent folios illustrating the great Exhibition will never be forgotten, as specimens of the highest order in coloured lithography, printed by Messrs. Day & Co. That, of course, he edited, but his Essay on Illumination exhibits originality and power. That book was privately printed, but it ought to be reproduced if the exquisite borders are still preserved. The design of the author is clearly expressed as that of attempting the revival of that form of art applied to the decoration of books by a detailed description—1, Of what the art of Illumination was; and 2, What the art of Illuminating should be in the present day. In this last section he treats of the materials at our command which were not used by our predecessors, who were confined chiefly to vellum; and in processes we have greatly multiplied in a way that will probably be of indefinite extension. The labour of the hand can be applied in countless ways—and we see in chromo-lithography and chromo-type how much has been, and is likely to be, done.

He sets forth the principles that should guide the student in working out his design, and the directions in which he should cultivate his task; based though they be on the examples of the best ancient illuminators of books, they contain the cautionary adaptations and instruction proper to our time. Then follows practical hints about tracing and tracing paper, the treatment of colours, varnishes, and all the other materials, whether for illuminating on books, walls, or wood, or ivory, with much charming discourse on the various details. Finally, the author writes of "the processes: ancient, modern, and possible," wherein are receipts many for the making and preparing of every substance employed, including all appertaining to distempering and varnishing. A memorable book.

The first annual meeting of the Arundel Society provided an opportunity for the delivery of a lecture on Sculpture in Ivory: its history, methods, and productions, and it is a work of singular erudition upon an elegant art but little studied save by connoisseurs and collectors. He vindicates it from the charge of possessing only an antiquarian interest, and declares it affects the artist of the present day by teaching through examples better than any other form of art study, that beauty attracts, and ugliness repels entirely irrespective of style. "The flame of admiration never has and never can fail to be kindled within us, if the fire of genius has burned in the artist even in an ivory plaque or triptych."

These many labours brought many honours, but although gold medals, knightly title and fellowships crowded upon him, we much doubt whether the course of lectures on Fine Art, a sketch of its history, theory, practice, and application to industry did not give him the greater pleasure. He held the Slade Professorship, and in that capacity produced this Course and its publication. We can only enumerate the subjects:—History of Architecture; Theory of Architecture; Practice of Architecture; Sculpture, in three lectures of the like description; Painting, ancient and modern, four lectures in same order; Fine Art as applied to Industry, ancient and modern, two concluding lectures. That occasion happened to be the first in the annals of the University when fine arts received due consideration. It, like all he did, is an exhaustive work, fresh in style, collected with great labour, and elevating in its aim and result. The reader rises a happier man from having contact with such thoughts and from acquiring such knowledge. Many and many a student will turn to that Course for inspiration and information.

But we fear our catalogue is extending beyond ordinary bounds, and hasten to close by reciting the honours conferred upon him. The learned Societies—Architects, Society of Arts, Civil Engineers, and the Academies of the Continent—did all they could; and commissionships without end were entrusted to his judgment, knowledge, and experience. The Queen knighted him in 1869, and around him, as the days of his life became fewer, friends abounded, insomuch that at his death, only a few weeks ago, science incurred another loss as great as when only so short a time previously his beloved friend and coadjutor, Owen Jones, passed away.

W. S. C.

NAVAL ENGINEERING.

PRACTICAL Science has no more useful employment in our day than the development of this range of subjects. Whether we regard politics, construction, or supremacy, the interests of power and of peace meet as on common ground when naval engineering has to be discussed. To the scientific a wide range is open; to the thoughtful, a wider; to the world in its generality there is an indisputable claim. Every year makes it more imperative that we should take note and try to guide our way.

Mr Brassey—than whom few are more distinguished for intelligence, independence, or power—has spoken on this subject words that deserve repetition and reproduction,—words that will most assuredly affect the future policy of not only our own but other nations.

Two gun vessels, from the firm of Sir W. Armstrong, were constructed for the Chinese Government, and were at Aden on the 16th April, having performed their voyage—a long one—from England satisfactorily. Upon this circumstance, arising out of his famous yachting tour, Mr. Brassey writes most important words, which we quote, because they affect manufacture and therefore the utilities of science in national affairs:—

"It has been urged most strongly by Mr. Barnaby that every monster ironclad should be supported by a flotilla of gunboats. Has due weight been given to this suggestion of the chief constructor, which received the strongest support from Sir Spencer Robinson and other authorities?

"As skirmishers, in combination with the monster ironclads of the Inflexible type, gunboats of the type designed by Mr. Rendel would be invaluable. In addition to the attendant flotilla of gunboats, each armoured ship should carry torpedo boats of great speed. When it is remembered that the blow from a single torpedo would prove fatal, and how improbable it is that such tiny craft, steaming at the rate of 17 knots, and enveloped in smoke, will be struck by heavy projectiles, it can scarcely be doubted that victory would incline in favour of that fleet which would possess the greatest number and the most effective of these light-armed naval skirmishers.

"Again, considering how impossible it is to construct an invulnerable ship, and that the costliest ships are almost as liable to destruction as those of a smaller and less costly type, ought it not to be a cardinal maxim with naval constructors and administrators to distribute the strength of the navy into as large a number of ships as may be, taking care, of course, that no ship shall be built which is too small to be thoroughly effective in its own particular class? Let us seek for the best practical application of this principle.

"The expediency of adding largely to the dimensions of an armoured steam boat, for the purpose of mounting an armament of two or four 80-ton guns is open to question on another ground. A captain may hesitate to open fire, and to obstruct his field of view by the smoke of a heavy cannonade, when he sees a cloud of torpedo boats hovering round him, only deferring their fatal assault until their movements are rendered invisible to the enemy by the smoke from his own guns.

"How, then, are we to meet these various and complicated conditions with which the naval constructor has to deal? It can only be done by adopting distinct types of ships for the use of the gun, the ram, and the torpedo respectively.

"The artillery of the fleet should be mounted on floating gun carriages of the Gamma type, designed by Mr. Rendel. For the torpedo each large ship should carry two or more of Mr. Thorneycroft's swift launches. For the purpose of ramming, a swift armoured ship of handy proportions is required; and, with the view to a limitation of size, and in order to secure that quality of handiness so vitally necessary to an effective ram, these vessels should not be encumbered with armour-protected guns.

"Let progressive, unprejudiced naval officers compare the kind of force that could be created for a given sum of money, if constituted, according to the suggestions here offered, with a fleet composed of vessels of the Inflexible type. I assume that armoured vessels can be built for £50 a ton. The Inflexible type, in round figures, has a tonnage of 10,000 tons, and costs £500,000. Five millions sterling, therefore, would produce only ten Inflexibles, which, powerful as they are, possess no special defence against the torpedo, are armoured with penetrable armour, and together carry only forty guns. A fleet of Inflexibles, it will be remarked, costs £125,000 a gun.

"I venture to believe that a like sum of £5,000,000 might be

much more effectively applied in the construction of the following vessels :—

1. Thirty armoured steam rams of 2000 tons, without guns, costing, at £50 a ton, each £100,000, . . .	£3,000,000
2. Sixty gun vessels of the Gamma type, armed with one 38-ton gun, two 12-pounder breech-loading guns, and one Gatling gun. Each £25,000,	1,500,000
3. Launches on Mr. Thorneycroft's plan, and other descriptions of offensive torpedoes and torpedo boats,	.500,000
	£5,000,000

"For operations in European waters, in the Mediterranean, the Red Sea, the Straits of Singapore, in short, along the whole line of our communications with the East, such a fleet as I have indicated would, in the hands of dashing commanders, be more effective than ten Inflexibles. Is the ram, as some think, the most formidable weapon of the navy, and is the quality of handiness the first condition of efficiency? Then thirty rams are matched against ten, and the smaller vessels, being more handy, are the more effective. True it is that the Inflexibles could steam faster than the smaller rams, and could therefore place themselves beyond their reach ; but such powerful vessels were surely not built to run away from an enemy.

"Is the gun the weapon on which we can rely? In the plan suggested eighty guns are carried as against forty ; and they are, for many purposes, mounted, so as to be more available than if carried in ships of the Inflexible type. For bombardments and for coast defence, a shallow draught is often essential in the vessels employed. It may be necessary that they should pass over shoals or navigate shallow channels. St. Petersburg and Cronstadt were inaccessible to our line-of-battle ships. They might have been destroyed by gunboats. Take, again, the question of coast defence. What could be done to protect the Thames, the Mersey, or the Humber, by ships drawing 30 feet, in comparison with the services which could be rendered by gunboats capable of navigating the inshore channels, and threading their way through the intricate maze of mud flats and sand banks with which the estuaries of our largest rivers are beset?

"In a naval engagement the utility of gunboats would be scarcely less apparent. Having double the number of guns, the chance of delivering a fatal shot is largely in favour of the fleet supported by a flotilla of gunboats. It may be thought that the gunboats could not sail in company with the larger ships. The plan of towing would meet this difficulty. For an example of what may be done with torpedo boats the recent experiments at Cherbourg are conclusive.

"Were half the money now so lavishly, and I fear vainly, spent on unwieldy and no longer indestructible or impenetrable ironclads, employed in procuring for the navy the means of destroying them, the naval administrations of other Powers would abandon the construction of armoured vessels. They would acknowledge the hopelessness of the attempt to give protection to their fleets by means of armour against the cloud of gunboats, torpedo boats, and rams which we could bring together against them. THOMAS BRASSEY."

THE HARMONIC TELEGRAPH.

ELECTRICIANS of the eminence occupied by Mr. Cromwell Varley and Sir Charles Wheatstone asserted many years ago that sound could be communicated by the agency which they had made it their special business to investigate and utilise. The idea, however, had only the interest which any curious speculation has for those who love to learn and to acquire the secrets of nature in order to their subjection to the service of man. In fact, it is a common idea. Savages knew not of electricity, but they could detect the coming horseman miles before he could be seen by placing their ears on the track. Wire communicates sound most marvellously. A well-made fence will carry sound through a distance of two miles, and it is not surprising that science, which is only the manifestation of nature and can only work upon her material, has announced a development that merely enlarges and magnifies what has never been hidden, howsoever feeble the knowledge.

The conveyance of harmonious sounds to a distance through the agency of electro-magnetism, is of course in immediate connection with telegraphy. It is a revelation—one of many hundreds yet to come. The uses are numerically incalculable, for therein are involved a variety of matters and capacities defying all speculation. Wandering in a country place in the silence of night who has not been delighted by the harmonics floating in the air produced by the mere breeze of heaven as it came into contact with the erected telegraph wires? That fact could not but teach any man of science the possibility of bringing into control that marvellous music of nature, and endowing it with the capacity of uttering the will and musical sentiment of man to distant places and in perfect form.

Philip Reiss of Friedrichsdorf constructed an apparatus in 1861 for the purpose of producing musical sounds at a distance by the agency of electro-magnetism. It was simple enough. A hollow wooden box provided with two apertures, one at the top and the other in front. The top was covered with a piece of bladder or gutta percha tightly stretched in a circular frame. There is a mouthpiece into which the operator can sing, and his voice is concentrated on the tightened drumhead, which is of course thrown into a state of vibrations analagous to those produced in the air by the operation of singing. A thin piece of platinum is glued to the centre of the membrane, and connected with a binding screw in which a wire from the battery is fixed. Upon the membrane rests a tripod, the feet of which rest in metal cups upon the circular frame, over which the skin is stretched. One of them is in a cup of mercury connected with the binding screw : the third consists of a platinum contact point, and lies on the strip of platinum placed on the centre of the vibrating membrane, and springs or jumps up and down with it. By this means the closed circuit that passes through the apparatus is of course momentarily broken at every vibration of the membrane—the drumhead. The receiving instrument consists of a coil or helix enclosing an iron rod, and fixed upon a hollow sounding box made on the principle declared by Professor Henry, that iron bars magnetised by an electric current become slightly elongated and at the interruption of the current are restored to their normal length. In the receiving instrument these elongations and shortenings of the iron bar succeed each other with precisely the same interval as the vibrations of the original tone : and the longitudinal vibrations of the bar are communicated to the sounding box, and are thereby made distinctly audible at the receiving station.

This apparatus could only produce what is known in acoustics by the term pitch. No variety in expression or change of tone could be produced. The contrivance, therefore, however admirable for its ingenuity and as a contribution to science, could not do more than give forth the monotonous sound of a child's toy. Moreover, the force dies ; and we very much question whether any invention will overcome that peculiar but essential element of difficulty. Electricty spends itself. There are limits. And sound is a troublesome property which, at the present, does not appear to be under control.

Reiss's idea had the assistance of Dr. Wright, who, noticing the weakness of the sounds emitted, suggested the passing of a current through the primary wire of a small induction coil, and by placing a condenser consisting of two sheets of silvered paper back to back in the secondary circuit, succeeded in producing, by its rapid charge and discharge, musical sounds of sufficient power to be heard in an ordinary public hall.

In one of Wheatstone's patents (No 2462, October 10, 1860) a date preceding Reiss, he sets forth as an outside portion of the claim for invention, its applicability to the purpose we are discussing. He would employ musical pipes or free tongues, similar to those of the concertina and harmonium, to the construction of telephones, in which the alternation of long and short sounds are grouped in a similar manner to the long and short lines in the alphabet of a Morse's telegraph, or in which two sounds are made to succeed in the order of the alternate motions which constitute the alphabet of a single needle telegraph. "I prefer to employ pipes or tongues producing very high sounds, since they require a much less quantity of wind than lower sounds. The passage between the reservoir of air and the pipe or tongue is closed by a valve which, when acted upon by an electro-magnet, opens and allows the passage of the wind to the pipe or tongue. The reservoir of air may be either a small gas-meter, a water blowpipe, an india-rubber ball collapsing by its own elasticity, or a bag impermeable to the air compassed by a weight or spring ; the air is in all the above cases restored when exhausted by blowing through a pipe furnished with a throttle valve, or by other means. Two such pipes or tongues producing different notes connected with the same or separate reservoirs, the valve of one acted upon when the current proceeds in one direction, and the valve of the other when the current proceeds in the opposite direction, constitute a telephone, of which the alphabet may correspond with that of the usual single needle telegraph."

Mr. Cromwell Varley's observations were still more direct and circumstantial, and he has the advantage of priority as respects

the existing schemes of Le Cour, Bell, and Gray. They are as follows :—

Mr. Varley's invention, like all telegraphic apparatus, consists of two instruments—a sender and a receiver. At a private trial at the Queen's Theatre both were submitted to examination, and a wire was laid extending across the river Thames and back—about three miles. In regular working the sending instrument will be at one place, and the receiver at the other. Let us consider the receiver first, for it is in it that the greatest novelty of the instrument consists. The only thing visible to the audience is a large drumhead or tambourine, inside which is stretched what appears to be a sheet of tissue paper. Nor is there very much more. Mr. Varley discovered the curious fact that if a pulsating electric current of "high tension" be sent into a "condenser," an arrangement of thin plates alternately of conducting and non-conducting materials, the plates will vibrate, and if large enough and of proper construction they will produce a musical note. The note thus formed is greatly magnified by the drumhead and can be made to sound quite as loud as the ordinary note, say of a hautboy, which, indeed, it much resembles. It is understood that this condenser has some special features of construction, but to all appearances it differs little from the ordinary condensers of tinfoil and paraffined paper which are used in electrical operations. No satisfactory explanation of this curious phenomenon has yet been given, but of its existence there can be no doubt.

The sending instrument is much more complicated. A number of tuning-forks, sufficient to enable a simple tune to be played by their means, are employed. Each of these has, mounted near its end, a small electro magnet, worked by a battery, by which it is kept in constant vibration, precisely, to take a familiar instance, as the strike of an electric bell is kept going when the button is pressed down. The vibrations of the fork are then caused to make and break a second separate electric circuit passing through an "induction coil," by which the "low tension" electricity of the battery is transformed into the "high tension" electricity required to produce the vibrations of the condenser. All these forks are then kept vibrating simultaneously, producing, of course, a rather discordant hum ; but the current from none of them passes into the condenser until, by the depression of a key, the circuit is completed between one of the forks and the condenser, when the note belonging to that fork is instantly sounded. A number of keys, one for each fork, are mounted on a key board, and they are manipulated just like pianoforte keys. The instrument at the Queen's has a compass of an octave and a half, from C below the staff to G above it, and there are consequently 12 forks with their attendant apparatus.

Of the music it is impossible to speak in very high terms. Some of the notes were good enough, but others were quite false, and the impression it gave was that the instrument was not properly adjusted and tuned. It was stated that its action is somewhat uncertain, and that it depends partly on atmospheric conditions. This is doubtless attributable to the use of high tension electricity which, as is well known, is difficult to manage over long distances. It did not appear quite evident why a single coil placed near the condenser would have not acted equally well ; but there are doubtless considerations of adjustment and the like which cannot be appreciated on a mere cursory inspection.

The whole apparatus was put up in considerable haste and under considerable difficulties. The Post Office refused to lend a wire, and so it became necessary to erect a private one. This involved the getting permission from the proprietors of houses in the line of route ; but it was successfully accomplished by the Gutta Percha and Telegraph Works Company of Cannon Street.

Should the present instrument prove all that is expected we are promised a speaking telephone ; and it must be confessed that such an instrument would be of far greater utility, as well as of greater interest, than a telephone organ such as that of Mr. Varley. The weak point of the American speaking telephone is the extreme lowness of its sounds.

This is certainly not the case with Mr. Varley's apparatus. We shall look with interest for a combination of the two,—for some apparatus in which the vibrations received by Bell's stretched membrane shall be given out by Varley's condenser. Such an arrangement, if the instruments can be cheaply worked and easily kept in order, would soon replace all the "A B C" instruments used for short distances and on private wires, even if it did not come into use for all our telegraphic communications. The instrument at present shown cannot transmit the sounds of the voice, nor can it take up and reproduce the music played by an orchestra or even a single musical instrument. All it can do is to produce in its own voice whatever tune is played on it. That it should do so at a distance of several miles is strange enough, but more than this is expected from the perfect telephone, and more than this will certainly be accomplished before very long.

The methods associated with the names of Mr. Paul La Cour of Copenhagen and Mr. Gray of Chicago are very similar, and were introduced to the world almost simultaneously. Gray had observed that if an induction coil were put in operation by means of an automatic electrome, and if one of the electrodes of the secondary wire were held in his hand while the dry finger of the same hand was rubbed upon a sonorous metallic plate, a tone proceeded, of a pitch exactly corresponding with that of the tone produced by the rapid vibrations of the circuit-breaker of the coil. He had a keyboard made containing two octaves, each key on depression exciting a steel reed tuned to a defined rate of vibration in correspondence with the musical scale. The vibration of that reed was maintained by the action of electro-magnets ; and the series of keys being arranged with reeds tuned to the different notes of the scale, the manipulation of a tune ensued, and the instrument became in fact an organ, the motive power of which was electricity in lieu of compressed air. It is apparent that such vibrations may be transmitted over a telegraphic line by merely connecting the main line with the reed, and thence through a contact-spring with the battery and earth. All the keys are connected, and the depression of one transmits a series of pulsations corresponding to its own note; and if two or more are touched at one time the result is that the pitch is given, and nothing more. Mr. Gray endeavoured to make these electric pulsations audible. He made a thin wooden sounding box, covered by thin metal and turned by an insulated crank, the metallic covering being connected through the stand with the earth. The operator, holding the connected electrode in one hand, presses his fingers against the metal plate which is turned by the other hand, and the tone which is being played at the other end of the line becomes sufficiently audible to be heard in a large room ; and the faster the plate is revolved the louder are the tones, or otherwise.

Now, we are not able to explain this phenomenon in a satisfactory manner, and the whole process is undoubtedly undergoing a course of development which may, on the one hand, result in a mere wonderment, or be turned to practical account. Meanwhile, it must interest every one who is of the sanguine temperament indispensable to progress; and every stage thereof ought to receive a general welcome.

The transmission of intensity as well as of pitch next engaged Mr Gray's attention, and he invented an apparatus containing two transmitting reeds, and two receiving instruments. Each transmitter was placed in a shunt wire around its own battery, while the main circuit ran directly through both batteries, so that each separate series of vibrations passed into the line in company with its own current. If two separate waves from two transmitters coincided, the intensity of the sound increased by the joint action of the two batteries, and, of course, a tune could be produced at any distance with accuracy so far as pitch and intensity were concerned. With a strong receiving instrument the tones were very loud.

Having established the practicability of transmitting distinct tones and reproducing them at a distance, the utilisation of these separate tones for the simultaneous telegraphic transmission of a corresponding number of different communications had next to be undertaken, the remaining difficulty being to effect the analysis of the composite tones into their constituents at the receiving station. Helmholtz had demonstrated this possibility, and all that remained was to discover the means. Gray made an instrument he calls an analyser, which consisted of an electro-magnet, the armature of which was replaced by a steel ribbon stretched in a metallic frame, and provided with a turning-screw at one end to provide proper tension. When tuned to a given note, this ribbon is thrown into vibrations on the pulsations from the transmitting-reed traversing the electro-magnet. But if any other note be transmitted it will not respond. If, however, its own note be transmitted as a part of a composite tone it will; but if the note ceases it stops. Consequently, it is only necessary to cause the main circuit at the receiving station to pass through as many analysers as there are separate reeds at the point of transmission, each of which is tuned to the same note as its own reed, and will respond to that note only, whether sent singly or as part of a composite tone.

In applying the apparatus to multiply telegraphic transmission, each electrome or reed is mounted and worked by the Morse key, by which the continuous tone is broken up into dots and dashes. The receiving instrument may be a simple Morse sounder, connected to the analyser, so that the analyser is a relay, opening and closing the local circuit of the sounder. There are simpler methods and also more complex ones: the fact is that we must wait the further development of this system of telegraphy, really not knowing whether the result will be a disappointment or a revelation. Professor Bell of Boston is fairly entitled to equal distinction with Mr. Gray in the investi-

gation of principles and in the faculty of invention, but the source of all their investigations is clearly traceable to the British sciencists Varley and Wheatstone.

THE PROGRESS OF PRACTICAL SCIENCE.

AMERICA honoured herself and also the world when she invited an International Exhibition of Results in Science, Art and Manufacture in order to celebrate her first hundredth year of nationality: which Exhibition was held at Philadelphia in the State of Pennsylvania. Names or places more appropriate could not have been imagined.

England passed a vote for the British Section, and it was administered with economy and efficiency. The results are published by authority, and are worthy of those who have described them, and of the subjects described: that is, the world has acquired knowledge it had not before, and been introduced to a larger range of observation than that it previously possessed. Politics and commerce are alike benefited with science and art; and so far as British interests are concerned, England occupied the most conspicuous place. All the world knows that the independence of America resulted from other causes than rebellion, and all the world has seen that the Mother Country—as they love to call us—recognises the events which have ensued with satisfaction and with hope.

Our business in this paper is to exhibit the contrasts which that Exhibition placed before us, so far as the departments recognised to be characteristics of the *Practical Magazine* are concerned; and this we will do by summarising the divers Reports from the judges authorised by the Crown and by Parliament.

These reports are of permanent importance. In the comparison of the Iron Manufacture of the United States with that of Great Britain, Mr Bell has made a report which reflects upon him much honour. Minerals, metals, machines, and all that belongs to them in the way of tools or apparatus, in the way of mining, and, which is of greater import, the science of metallurgy, were well represented at Philadelphia; and as he had the assistance of twenty qualified men from every part of the world, there cannot be a question about the arrangements being good.

Minerals are everywhere: the nonsense uttered to the contrary is out of court. The question for communities turns on the point of who can bring them up at the cheapest rate, and get out of them the greatest profit. Great Britain, with the smallest quantity in stock, has supplied half of the world's requirements on these terms. She has produced at the cheapest rate, and obtained the greatest profit. Her sons aid, as they ought to do, in this game of emulation. Pig iron is, by Bessemer, turned into finest steel that eclipses the quality supposed to be inherent to Swedish iron. By her commerce England arranges the manufacture and transfer of goods on terms that do not permit of a destructive rivalry. By her honour in the course of business, there has arisen a belief among the nations that honesty grows in the British Isles to as great a proportion as in any other part of the world. The consequence is therefore manifest. England holds the iron market.

In putting the case of England's position, it must be understood that there is no assumption of excellence. The position is derived from circumstance. Scotland, Wales and England proper, all contribute; but there is nothing of nature's material in those places which is denied to many others. Australia would rival America, and the Continent would rival both, if uniform conditions could be imposed.

Sweden is essentially an iron-producing country. The catalogue of her exhibits at Philadelphia is a compendium of the manufacturing processes which at once proclaim the enlightened character of the rulers of that kingdom, the practical qualities of its people, and the wealth which God has placed in their trust. The Swedish Iron-Masters' Association lent maps and collections, drawings and analyses, not forgetting the tabulated results. Sweden is distinguished for metallurgists, and to them is to be attributed, to a certain extent, the popularity of the Bessemer process, which, while it made English pig-iron into steel, and therefore destroyed the monopoly of Sweden in the steel market of the world, exposed to them a new range of ideas and processes. This enabled them to improve for the time the manufacture of their own material and sustain their own reputation, when English Mechanical Engineers were crying down their best iron-making friend and benefactor.

America has followed. The Bessemer process has been the making of the iron trade in Canada and in the United States. The comparative purities are illustrated by that method in the fiercest and most undeniable forms; and the enormous growth of the American iron-production is due entirely to the genius of that distinguished Englishman; because the inherent qualities of the material were revealed which before had been unknown, and therefore all have been enriched thereby. Questions of wages, strikes, and tariffs would involve us in politico-economic controversy of no practical worth; they nevertheless are important: the western world is supplying an ever-increasing revenue to wealth, invention, manufacture, and science: this is as honourable as it is dutiful.

The treatment of iron has been a subject of much speculation in every iron-producing country; but to the American genius must be ascribed the initiative of a thorough change. Labour happened to be excessively costly in that country, and the price of puddling became considerably higher than in Great Britain. Machinery, the ever fruitful resource in human affairs, had to be resorted to. Mr. Danks, of Cincinnati, invented a revolving puddling furnace, which was introduced into England at a cost of £100,000, and at a loss of the money; but there is no doubt that mechanical puddling will be the only treatment in a very short time; and so it ought to be. Human labour has a dignity higher than such laborious manual operations, and can find employment in work more worthy of human intelligence. The revolving furnace will supersede all other processes or modes.

Mr. Bell speaks of "Cold-rolling" in which bar-iron is passed through rolls a dozen times, and comes out with a surface so bright and clean as to serve, without preparation, for shafting or piston rods, and increasing its hardness and tenacity. In his concluding remarks he refers to a very practical matter—the conditions which now exist. America has overproduced material, and thereby enhanced wages, which reacting, has given a factitious value to iron, and generated unhealthy conditions all round. These miseries have been augmented by a system of protective duties injurious to the interests of a nation of infinite natural resources; and Mr. Bell's conclusions cannot be disputed by any candid man of intelligence.

We turn from this to the attractive subject of Ceramic and Glass Ware, as reported on by Mr. Soden Smith, the Art Library keeper at South Kensington. One third of the six hundred exhibitors were American, and the objects included almost every variety that is manufactured in porcelain and cement; the same remark may be applied to glass. We were in our last number referring to the subject of cements and Japan. It happens to be necessary to supplement those statements by some of the facts brought out in the Soden Smith report. Europe disdained, or was not capable of eclipsing the old world in ceramics. Japan supplied the most important contributions as became the traditions of that country. The variety of pottery, both hard and soft, known as Satsuma and Kiyoto especially: the soft creamy ground, its delicacy of tone enhanced by the reticulation of minute cracks which pervade the glaze, forms an effective surface on which to scatter the profusion of flowers, birds, insects, &c., in which their artists delight. The moulding of the pottery was surprisingly clean and ingenious, as for example, a pair of large cylindrical vases, surrounded by a complete case of open work of uniform outline, even and true in execution.

Stoneware, decorated in a bold manner in colours of enamel printing in slight relief; examples of ancient works, in imitation, most curious and deceptive; Porcelain Vases, among the most remarkable ever shown, such as vases eight feet high, in two portions, perfectly potted and gorgeously decorated; large slabs of hard porcelain, six feet in diameter, of fine texture, level surface, and even glaze, beautifully decorated, with flowers in blue on a white ground; screens, formed of thick slabs, three feet by two feet six inches, effectively ornamented,—the ground colour being a fine deep blue, with sprays of bamboo in white. How slabs of such proportions are baked is a secret, and neither side shows any marks indicative of the process; both surfaces are finished so as to be suitable for ornamental screens.

The display of blue and white china attracted every observer. The painting in blue underneath the glaze is said to be prepared from native oil containing cobalt, and the designs are artistic and not imitative. A richly ornamented ware made in Kiyoto furnished striking and splendid examples of decoration, having the ground painted all over with a fine red, produced from oxide of iron, the art of making and using of which is kept a secret in the family of its discoverer. On this gorgeous ground-tint, varied and complex mythological and other designs are applied in gold, with the richest result.

The growth of taste in favour of ceramic ware is seen wherever an exhibition is held. It is shared by every nation. Denmark has a new trade in the fine red and buff coloured ware, vases, cups, &c., of classic style and of elegant form and outline. Devonshire terra cotta, peculiarly suitable for statuettes, vases

of excellent and uniform tone of colour, is a late creation having works at Watcombe. Lambeth, famous long, has increased its catalogue tenfold in ten years, and as we have seen in London can have an exhibition of its own and most attractive. Spain is reviving her ancient glory for tile-making in the finer styles and in forms unusual but elegant. America has its Etruria in Trenton, New Jersey, and of that Mr. Soden Smith gives an extended description which we abridge. It aims to contest our supremacy, and the excellent natural material, the great industrial skill at their command, enables them to offer a bold challenge.

The principal productions are "granite" and cream-coloured wares, with some Parian. The former resembles our stone-china, being a white earthenware fired at a high temperature and covered with a thin hard glaze. In the best specimens, the body is extremely close, compact, and hard: the glaze then, well applied, hard, and not easily injured. It is a great favourite of the public, heat does not injure it by cracking. Wedgwood in 1760-70 expressed his apprehensions as to the effect of the American manufacture upon English trade and prosperity. The porcelain industry dates from about 1830, and for several years produced white and decorated tea and table services and ornamental pieces at reasonable prices. The body was sound, brilliant, tough, and with a hard glaze, but the decoration lacked taste and the enterprise ultimately failed. Others followed producing door-plates, knobs, &c., cups and saucers, of little account and bringing no commercial profit.

But about the year 1854 an effect of a higher type resulted in creating a new trade. The Yankee not only aimed to match our quality, which of course he could do with the fine clays of that region, but he forged the names of our best manufacturers. The growth of trade, and the improving morality of American commerce, has however nearly extinguished that bad practice.

The body of their "white granite" is very white, hard, and dense, partly vitreous or vitrescent, not porous, and of great plasticity: remarkable from its entire freedom from iron-spots or other impurities. The glazes are of good medium hardness, are well incorporated in the body, and not so liable to crackle as those of other countries: they are full, transparent, take colour well, especially muffle hard-fire colours, evenly and richly. The forms are in imitation of the French and English, and the decorations also. The trade has grown to be one returning about two millions sterling a year.

The general newly awakening regions, such as Mexico, Brazil, the Argentine Republic and Canada, are also placing themselves in the lists of competitors, and as clays of suitable qualities abound in all their dominions the industry will increase the wealth and employ the labour of the inhabitants.

Great Britain naturally occupied the first place in every sense; in quantity, variety, quality, design, and excellence of material. The terra-cotta especially attracted notice, and as that branch is eminently a British production and a rapidly growing industry, a brief digression may be of service; first in the combination of red terra-cotta and stone-ware: and second in that of terra-cotta proper.

In the centre aisle of the main building stood a temple of circular form and 30 feet in height, formed of red terra-cotta and stone-ware with flower vases round it: a striking evidence of the advance of pottery in combination of materials, exhibiting the utility of art and its power in conferring on the humblest material the most excellent beauty. The manufacture in such material might be excellent, and its selection admirable, but it might issue in the production only of drain pipes, had not the skilful manufacturers, appreciating the worth of art, found or obtained methods for decorating these rude elements until they were worthy of being set in gold and silver. We only indicate the method of ornamentation employed. While the ware is soft, subjects are drawn upon its surface with a pointed tool or style, and colour is added in the lines. Surface modelling is also used to a large extent. In other cases the decoration is given when the ware is hardened. The beading is generally done by children who acquire the art of placing each pearl according to pattern separately. The salt glazing covers the whole surface with a very thin, hard, and equally distributed glaze, and by aid of special method of managing the furnaces during the process, the colours applied are harmonized or blended.

An example of terra-cotta was sent which is described as unsurpassed for magnitude and importance:—a colossal group reproduced from one of the corners of the Albert Memorial and emblemized America. Probably no larger work of the kind has ever been attempted, and its execution showed great skill in overcoming difficulties. Terra-cotta is an excellent aid to architectural decoration as a material in cities where the impure atmosphere affects injuriously many kinds of stone. It has been successfuly tried in London and in the northern cities: it is coming into use in the States, especially in Boston, but the material is supplied from England, which by some means or by tradition has the reputation of supplying the best, a point of great importance in the purpose designed. It is an old servant. There are specimens dating from the reign of Henry VIII. in public places, in perfect preservation, of the red kind resembling the Roman brick material.

France in the light delicate artistic descriptions excels all. Germany and Italy are not worth observation; and had it not been that in our last number we had treated of Japan, it would have been our duty to have spoken more fully than has been done on their superiority. Of glass we shall have occasion to make note next month.

Sir John Hawkshaw has contributed a report on Architecture and Engineering that contains what we have not learned previously, notices of the great works proceeding in America, and in particular the original and bold operations, and the machinery for the removal of the reef at Hallet's Point, Hell Gate, New York, which projected into the Channel at Hellgate about 300 feet and at low water covered by less than 12 feet of water. The object of the improvement was to widen and straighten the narrow and crooked channel by securing a minimum depth of 26 feet of water over the reef. A model illustrative of the operations formed a part of the contents at the centenary display, and Sir John gives a description of the works which commenced by building a coffer dam between high and low water marks. In October following the excavation of the shaft was begun. From the bottom of the shaft 10 tunnels were driven under the river in radial lines and were extended until a depth of water upon the reef of 26 feet at low tide was reached, the roof of the excavation being kept nearly parallel to the bed of the river and about 10 feet below it. The main tunnels are about 14 feet in width, varying from 10 to 20 feet in height and averaging about 270 feet in length. They are connected with each other at intervals of 30 feet by means of cross tunnels or galleries of about the same height and width. Between the tunnels and galleries large columns of solid rock were left to support the roof of the excavation or bed of the river; these large columns were afterwards cut through by other tunnels and galleries, and finally 173 piers or columns were formed averaging about 10 feet each in thickness. The entire roof thus undermined covered an area of three acres. The aggregate length of tunnels and galleries driven under the bed of the river was 7,425 feet. From the excavation about 47,460 cubic yards of rock were removed by drilling and blasting, an operation which required 208,174 lineal feet of drill-holes, of which 90,107 feet were drilled by hand and 118,067 feet by various kinds of machine drills, viz., The Burleigh, Diamond, Rand, Winchester, Wood, Ingersoll, and Waring drills, worked by compressed air.

The usual method of driving a tunnel or gallery was as follows: the face of the rock was pierced obliquely with as many drill-holes from 3 to 4 feet in depth as were deemed necessary; the charges were then prepared by placing the explosive material in water-tight paper cartridges from 8 to 12 inches long and containing from 8 to 12 ounces of explosive mixture; into each of these cartridges a copper cap containing mercury fulminate fastened to the end of a piece of safety-fuse, generally about 5 feet in length, was inserted. The cartridge was then pushed to the bottom of the hole, which was filled with water; the ends of the fuses hanging from the drill-holes were then ignited.

In the preliminary operation of forming the tunnels and galleries the following quantities of explosives were used:—

Blasting powder	24,431 pounds
Nitro-Glycerine	26,471 „
Giant powder	1,932 „
Mica powder	600 „
Vulcan powder	4,017 „
Rend Rock	1,500 „

In exploding these compounds 63,756 exploders and 331,516 feet of Bickford's safety-fuse were used. In all about 75,000 blasts were fired.

A good model showing the tunnels and galleries and the pillars left to support the roof was sent to the Exhibition. When I visited the work at the beginning of August last holes had already been drilled in the pillars and roof to receive the explosives for the final explosion. These were intended to be charged with nitro-glycerine cartridges to be connected by wires with a battery to be placed at sufficient distance. It was intended before making the discharge to fill all the tunnels and galleries with water. The explosion took place a few weeks after I left.

The machine used throughout these operations for removing reefs and rocks under water by blasting from the surface is called a Steam Drilling Scow. It consists of two parts, a large float or scow, having a well-hole in it of a diameter of 32 feet, and is built very heavy and strong; it is provided with an overhang

or guard around it faced with iron, and is capable of withstanding violent collision with other vessels.

Besides affording this security it serves also to transport the caisson or dome from place to place, and is a working platform from which the drilling engines are operated. The caisson or dome is a hemisphere of the diameter of 30 feet, composed of a strong iron frame covered with boiler iron. The dome is open at bottom and at top, and is provided at the bottom with legs to support and level it, which are arranged to let go altogether after the dome is lowered.

The hemispherical shape of the caisson is favourable to stability. The caisson or dome is simply a framework affording a fixed support to 21 drill tubes through which the drills operate. The dome is connected with the scow by four chains communicating with four hoisting engines, by which it is lowered or raised. A framework is built upon the scow around the well-hole to support the carriage holding the drill engines, which by these means may be placed directly over the drill tubes. The engines simply raise the drill rods, and allow them to fall by their weight upon the rock, the vertical play being 18 inches; the drill and drill rods together are about 10 feet long, and weigh from 600 to 700 lbs. The cutting edges are in the form of a cross, and are 5½ inches long.

The scow having the dome swung by chains is first anchored over the rock to be operated upon, so that the bow and aft moorings pull against the direct currents of the ebb and flood tides, but as these may vary somewhat in direction from one tide to another, as well as during the course of the same tide, it becomes necessary, in order to steady the scow, to have side anchors also. The diver descends to ascertain whether the location is well suited to placing the dome on the bottom, and if not, to select a better. The required change in the position of the scow is made by lengthening and shortening the mooring chains with capstans, which are arranged to be worked at will with steam or man power. The dome is then lowered, and when it touches or approaches near the bottom the legs are let go, and being held by self-acting cams support the weight of the dome. The chains are now unslung from the dome, which is thereby without connection with the scow. The diver descends to ascertain which of the drill tubes it is necessary to use to break up the rock within the dome, and how the surface offers itself to each particular drill. The drill rods being introduced within the drill tubes, which is easily effected during the most violent currents, a rope or other flexible connection is now made between the top of the drill rod and the piston rod of the drilling engines. A flexible connection is necessary to the act of drilling, as in this machine, the dome remaining fixed upon the bottom in one position, while the scow holding the drill engines swings for short distances from changes in the directions and strength of the currents, no rigid connection between the engine and drills would be practicable. The length of the rope attachment is regulated by a feed-gear for the rise and fall of the tides and continual changes of water-level.

The drilling being completed, preparations are made for charging the holes with nitro-glycerine. The chains are hooked on the dome, which is then raised from the bottom, and the scow swung off from the spot to a safe distance without casting loose the moorings. This distance will depend upon the proposed amount of charge of nitro-glycerine, and will vary from 175 to 350 feet. The nitro-glycerine, in tin cases of different lengths, to suit the varying depths of the drill-holes, is carried to the spot upon a small scow, from which the diver descends to the first hole to be charged. He is guided to this by a line. Withdrawing the plug, he introduces into the hole the tin cartridge, which has been filled by the men on the scow and passed down to him. Each cartridge is attached before it is sent down to the wires. The diver then passes on to the second hole, guided by the plug-line which connects the stoppers of the adjacent holes, and in this way the whole circuit of holes is visited and charged. The leading wires are connected with the battery, when the small scow has been withdrawn, and the explosion is made.

To break up the rock thoroughly the drill-holes should be from 6 to 8 feet apart, of the size of 5½ inches at the top, and charged with amounts varying with the depths of hole, which will average between 50 and 60 pounds for each, and the depth to which the drill hole should reach below the level to which it was desired to break the rock is about four feet.

After the rock broken by the explosion covers the greater part of the reef its removal is commenced. This is effected by means of a steam grapple.

Railway Appliances.

Brakes.—The brakes on the American railways have been perfected to a far greater extent than in this country. This appears to have arisen from the necessity for the rapid stopping of trains, introduced by the less secure condition of fencing on American railways, and the greater prevalence of single lines.

It would seem moreover to be recognised as an axiom on American railways,—

1st, That the engineer shall have complete control over the application of brake power to all the wheels of the train.

2nd, That in case of the accidental fracture of couplings the detached cars shall be at once brought to rest by the action of the brakes attached to them.

The Westinghouse Brake appears to have obtained the confidence of the American railway managers, and it is applied very extensively on American railways. The Westinghouse Air Brake Company, Pittsburg, Pa., in America, have bought the patent of Smith's Vacuum Brake. They state that they apply this latter occasionally as being less expensive, where rapidity of action is not of parmount importance; but for all passenger trains they recommend their own automatic brake.

The difference between the two broadly stated is, that in the Smith's vacuum brake the application of the brake depends upon the vacuum in the pipes. In the Westinghouse automatic brake, the brakes are applied by a diminution of pressure in the pipes.

The Westinghouse Air Brake, now in use upon two-thirds of the railways of the United States, consists of an air pump driven by steam taken from the locomotive boiler, by which air is forced to a pressure of about 80 pounds per square inch into a reservoir fastened under the foot-plate of the engine. From this reservoir a pipe leads to one opening of a three-way cock, while from a second opening the brake-pipe is extended down beneath the tender and the entire length of the train. Under each car, near the centre, a cylinder fitted with a piston is firmly bolted, having a connection from the piston to the ordinary brake lever, and a branch leads from the main brake pipe to one end of this cylinder. The pipes from car to car are joined by flexible tubes, having malleable iron couplings, which are provided with valves. When these couplings are united the valves are forced open, so that there is a free passage from the three-way cock, the entire length of the train, to the last coupling, where the valve not being unseated, prevents the escape of air.

The handle of the three-way cock, before alluded to, is under the immediate control of the engineer, so that by a simple movement of the hand, he can bring the pipe from the reservoir in communication with the brake-pipe, whereby air is forced through the pipe and into each of the brake cylinders, setting the brakes almost instantly, with any force desired up to the maximum, which is only limited by the amount of pressure carried into the reservoir.

A return of the handle of the three-way cock to its former position first closes the communication between the brake-pipe and reservoir, and then opens the communication from the brake-pipe to the atmosphere, whereby the air is discharged and the brakes released by strong springs, which force the pistons back.

The Westinghouse Automatic Brake differs from the air brake by having, in addition to the main reservoir on the locomotive, an auxiliary reservoir located upon each car in the train. The branch from the main brake-pipe instead of leading directly to the brake cylinder, leads to one opening of a small triple valve-device, passing through which, it enters this reservoir; through a third opening the pipe leads to the brake cylinders. The construction of this valve-device is such that, if air be turned from the main reservoir into the brake-pipe, the auxiliary reservoir will be charged with the same pressure, while at the same time an opening will be made from the brake cylinder to the atmosphere. After the reservoir has become charged, if the air be discharged from the brake-pipe by the engineer, or otherwise, it will cause this triple valve to shift, so as to close the opening from the auxiliary reservoir to the brake-pipe, and from the brake cylinder to the atmosphere, at the same time opening a direct passage from the auxiliary reservoirs to the brake-cylinders, applying the brake to the full force of the pressure in the reservoir, less the reduction caused by expansion in a larger space.

It will be seen by the above description that the brakes are off when the pipe is charged with compressed air, and that the brakes are applied by the reduction of pressure in this pipe. A valve arranged in the brake pipe on each car, with a cord extending through the inside of the car, enables the conductor or brake-man to discharge the air from the pipe, thus setting the brakes on the entire train. The separation of the train, and consequently of the hose-couplings between the cars, discharges the air and applies all of the brakes.

At both ends of each car a cock is arranged in the pipe, and the cock at the rear of the train is closed to retain the pressure; when the train is separated intentionally, the cocks in the pipe are closed where the separation is to take place before the couplings are disconnected, preventing the application of the

brakes. The force with which the brake is applied is entirely under the control of the engineer, who governs the amount of the reduction of the pressure in the brake-pipe. Both halves of the hose-coupling are alike, and that permits the use of a single line of pipe : these couplings are so constructed that they are perfectly air-tight when united, but can be separated forcibly, by the breaking of a train, without injury.

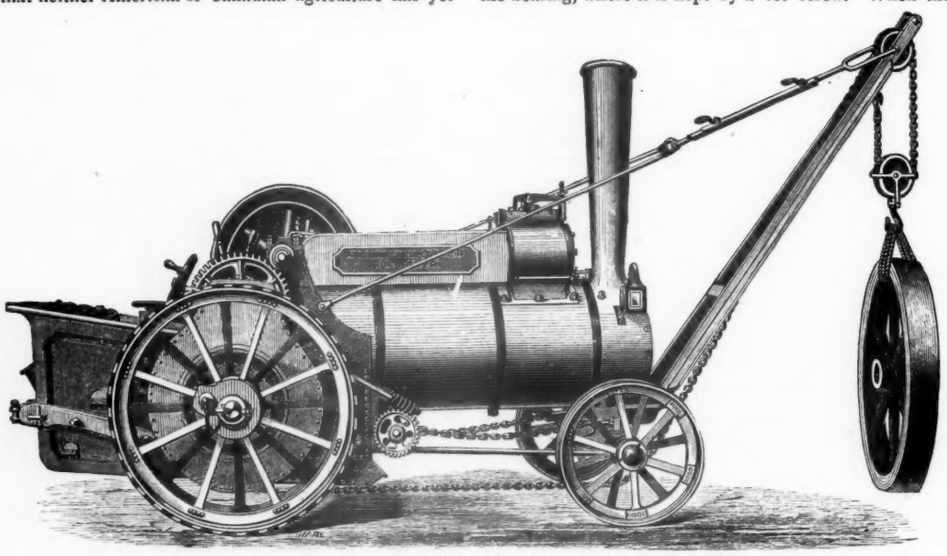
We must not omit to mention Mr. Steele's patent, which is of the same principle, for which he claims greater superiority in the parts.

Wheels of Compressed Paper.—The central portion of the wheel is entirely of paper, compressed by hydraulic machinery to the consistence of wood, but without the liability to split, which wood has more or less ; the hub and the tires are of steel. These wheels are run under the Pullman cars, and a wheel was exhibited which had run for eight years under a Pullman car, for a distance of 302,900 miles, the tire of which showed very small marks of wear. The duration was attributed to the elasticity of the material. The cost of these wheels was stated to be for a 30-inch and a 33-inch wheel 42 dollars, for a 42-inch wheel 60 dollars. Another form of wheel in which durability was sought in elasticity was a form of locomotive driving wheel, to which steel tires were fixed, with blocks of hickory between the felloe and the tire, so as just to relieve the tire from resting on the iron rim. This class of wheel is stated to have been in use some years, and to have given very favourable results.

Agricultural Machines.

Mr. John Coleman, in his report, expresses his reasonable surprise that neither American or Canadian agriculture has yet adopted steam culture. Considering the cheapness of fuel and the vast area of many of the farms, together with the flat character of the prairies, he thinks it remarkable. It is not necessary to delve very deep, and cattle are cheap, the land is light, and perhaps there is not the necessity ; but certainly America is behind our Colonies in this particular. Messrs. Aveling & Porter of Rochester, sent one over, and as that is among the best we use it as an illustration. (Fig. 1.) It consists of a single cylinder, surrounded by a steam jacket in direct communication with the boiler by means of steam ways or orifices, made in the top of the boiler. Priming is avoided by placing the cylinder in the forepart of the engine ; and on ascending inclines the cylinder is, of course, fed with dry steam, while in descending very little steam is required. It requires, in fact, no steam pipes inside or outside. Engines of this kind, having single cylinders and reversing gear, and chain gear connection with the driving axle, have been found perfectly efficient. They are not so complicated as engines with double cylinders, and therefore are better adapted for traction purposes.

The working parts are housed in from the weather, and the toothed gearing is covered with light iron splashers. The propelling gear consists of a pinion at each end of the crank shaft, working into spur wheels on a counter shaft below. On this shaft is a chain pinion, with chilled teeth, to take in a pitch chain made of wrought iron links with steel pins. In the brackets carrying the shafts there are curved slots, stuck from the centre of the crank shaft above for taking up the slack of the endless driving-chain. These pinions are kept in position by a simple clip of spring steel embracing the shaft, and lined with leather. The slackness of chain is adjusted by brass bearings, that carry the shaft, being kept up by a slot in the bottom of each. Another block is above, made of cast iron, lying on the bearing, where it is kept by a set screw. When the chain



(Fig. 1.)

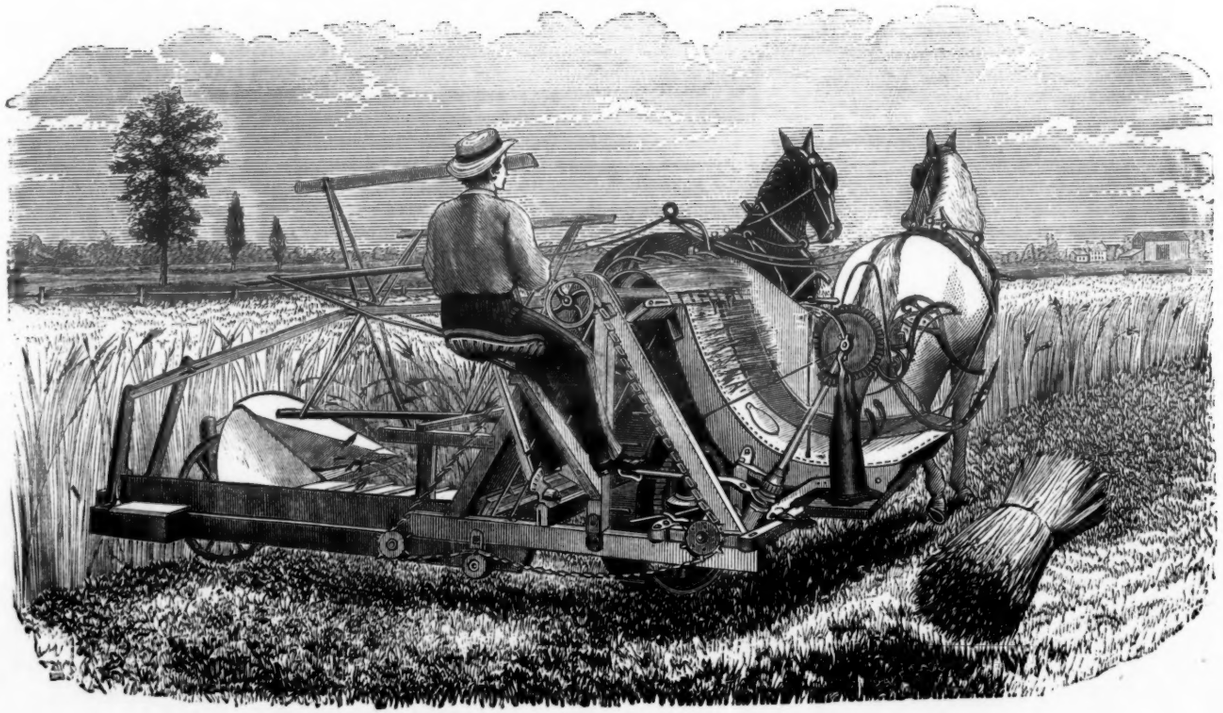
has to be shortened, the thinner block below is removed and the thick one substituted ; the brass step is thus fixed in a perfectly firm and adjustable bearing. The connection of gearing is by an endless chain, which passes round the chain pinion on the counter shaft and a large chain wheel keyed on the axle. These driving wheels are 6 feet 6 inches in diameter, they are faced on the outer tire, from which parts can be removed when applied on light and soft ground. The boiler is carried through from end to end ; the stay bolts are pitched 4½ inches from centre to centre ; the fire-box will take wood or coal ; the water is carried in a tank of wrought iron, bolted to the side of the projecting fire-box ; and the draw-bar of wrought iron is bent back and bolted back to the side of the tank.

A single disc wheel suffices for steerage, carried on a vertical spindle, and attached to the fire carriage of the engine, the upper end has a lever connected with the driver. This engine can easily do 40 tons on a level road, and with a load of tons would easily take 20 tons up an incline of 1 in 12. These engines we have described at length, because they are very much used in our own Colonies in the West Indies, South America, Egypt, and Japan, and the increasing tendency for using steam on common roads is creating an immense demand for them as railway feeders.

Another machine, called an Automatic Binder, became one of the marked features of the Exhibition. It realises a long-wanted and much-desired combination. Manual labour gives place to a mechanism which binds the sheaf with wire, twists the wire, cuts it off, and either throws the sheaves as they are made with a spring, or as they are extruded by the sheaf that follows. It is the first occasion of its being exhibited. (Fig. 2.) It is from the factory of Mr. Wood, Worship Street, London.

Chemistry.

The Professor of Chemistry at the University of Oxford has, in his report of his visit to America during the recent display, contributed a valuable item to the general store of knowledge. He found that the chemical arts illustrated by that collection of chemical products had attained surprising development : first, in the superior quality of the products furnished by long processes, and by the more extended use of processes of recent



(Fig. 2.)

establishment; and, lastly, by the introduction of altogether novel processes and products of manufacture.

We will condense his observations.

The alkali manufacture aims to produce carbonate of soda in various commercial forms, especially soda-ash and caustic-soda; formerly obtained only from soda-ash in solution, or lye, made by the maker, but of late years in a solid state, and at a great saving of cost, as a regular part of alkali manufacture. Now both carbonate of soda and caustic soda are extracted directly from an intermediate product—ball-soda, which is got by heating salt-cake, or dry sulphate of soda, with coal and limestone; the salt-cake being got by the action of sulphuric acid on common salt, and the sulphuric acid itself got by the combustion of iron pyrites under special conditions.

The usual course of operations for producing soda requires coal, limestone, common salt, and iron pyrites. In the combustion of pyrites to obtain sulphuric acid there remains a residuum, formerly wasted, but now furnishing metallic silver, copper, and marketable iron oxide. In making salt-cake from sulphuric acid and salt, muriatic acid is produced, and that was a waste until science taught that we could make of it, by the aid of native manganese-oxide, chlorine gas, which is absorbed under different conditions by lime and potash in the manufacture of bleaching powder and chlorate of potash. Again, in the action of muriatic acid on manganese-oxide to evolve chlorine, there is a production of chloride of manganese, and that was formerly a waste product, which now refurnishes manganese-oxide, and, in these days, the use of the native mineral is reduced to a mere fraction of the entire use of the manganese at chemical works. By the extraction of the crude soda from the ball-soda an abundant material known as soda-waste remains, which, although known in sulphur works, or as a source of antichlore, has yet to be employed for other uses, when demand shall make discovery and application necessary.

Hargreave's patent is the latest process in alkali manufacture. Salt-cake had previously been formed by combining common salt with sulphuric acid under the influence of heat. For the production of the necessary sulphuric acid, the sulphurous oxide gas from pyrites is received in enormous leaden chambers charged with air steam and specially produced nitrous fumes, it is converted into liquid sulphuric acid strong enough to act upon salt. By Hargreave's process the sulphurous oxide gas from burning pyrites, together with the excess of moist air, is passed at once over hot common salt, and salt-cake and muriatic acid are produced, dispensing with the prior and separate conversion altogether. The saving is great; but much scientific interest is felt for new ideas, and methods are suggested. The Runcorn (Cheshire) Alkali Company work by its directions.

There is, however, an altogether different process adopted by Brummer, Mond, and Co., and some foreign houses. It is known as Solvay & Co.'s of Belgium, and the object is to obtain carbonate of soda from brine. The brine, as pumped up from the salt mines, after being purified by the action of lime-water and a little carbonate of ammonia, is saturated with ammonia-gas obtained from gas-liquor. The ammonial liquid is then subjected to the action of carbonic acid gas injected under considerable pressure, whereby bicarbonate of soda is deposited and sal-ammoniac left in solution. The deposited soda-salt is collected, washed, and ignited, whereby it yields a soda ash of high strength and purity. The sal-ammoniac solution is distilled with lime, and the ammonia gas thereby evolved condensed in a fresh portion of purified brine, and so on continuously, gas-liquor being resorted to as a source of ammonia only in the first instance, and to compensate for accidental but unavoidable loss in the process. It is observable that this process consists substantially in the conversion of limestone and common salt into carbonate of soda and chloride of calcium, the ammonia constituting, so to speak, merely the apparatus of conversion, and no other product of value except carbonate of soda being obtained.

The extraction of soda and alumina from cryolite is another and a different method of alkali production. The basis of this manufacture is the rocky mineral known as cryolite, which is a double fluoride of aluminum and sodium. This material, having been finely ground, is fritted with lime, whereby it is decomposed, so as to furnish insoluble and practically valueless fluoride of calcium, together with alumina and soda capable of extraction by water. By treatment of the watery solution with carbonic acid gas there is produced a precipitate of alumina, highly valuable for the manufacture of alum-cake and ordinary alum; while carbonate of soda is obtained by subsequent evaporation of the solution. The Pennsylvania Salt Manufacturing Company practise this method, but it will be employed in many parts of the world when demand increases sufficiently to engage capitalists.

In another paper, we have noticed the process of extracting coal-tar and its distillation, but in addition to the novelties connected with this branch of chemical industry, it is important to watch the artificial production of the madder dyes, alizarine, and purpurine; the production of salicylic acid by Kolbe's process; and the introduction by Baryer of a new dye-product, Eosine, which is equally interesting to the scientific man as to the merchant.

Gas coal-tar heated in stills of 2000 gallons yields—1, Coal tar naptha,—2, creosote oil,—3, anthracine oil, and 4, pitch; each about one fourth the original quantity of tar. From the naphtha is extracted aniline and all the series of aniline colours; when rectified and boiled with chlorine it yields benzylene dichloride, which distilled with alkali gives esential oil of bitter almonds.

The usual course of production of the principal aniline colours is briefly as follows:—Rectified coal-tar naphtha, consisting mainly of benzol and toluol, is acted on by nitric acid so as to furnish commercial nitrobenzol. This highly oxidised compound is next reduced by means of iron-turnings and acetic acid into aniline. This reduced aniline is then oxidised, usually by means of arsenic acid, whereby crude aniline-red is produced, which is afterwards subjected to various processes of purification. Purified aniline-red is the crystalline salt—usually the acetate or hydrochloride—of a base known as rosaniline. The acetate of rosaniline, heated with aniline, is converted into phenylated rosaniline or analine-blue. Rosaniline itself, heated with the iodide of ethyl or methyl, is converted into the ethylated or methylated rosanilines known as Hofmann's violets. And lastly, by combination of the base of the violet with more iodide of ethyl or methyl, so as to form, for instance, a methyl-iodide of the fully methylated base, there is production of aniline-green.

The improved manufacture by Coupier consists in making aniline-red without arsenic acid; Hofmann violets without iodine; and converting the base of those violets into aniline-green without the use of iodine. The series of colours are magnificent; they surpass in quality all ordinary results, and are advantageous because the deleterious ingredients are not required.

Out of creosote oil is extracted carbolic and cresylic acids. Carbolic again is the source of the valuable yellow dye known as picric acid, obtained by careful union of carbon and nitric acid, resulting in pale yellow crystals. The salts of this acid is used for explosions. Carbolic acid also gives an orange-red, colouring matters known as aurine or coralline, and sometimes as rosalic acid, when heated with oxalic and sulphuric acids. It also supplies salicylic acid by much simpler methods than before.

The later portion of the creosote oil furnishes on cooling an abundant crystalline deposit, known as "salts." This beautiful crystalline is the source of various colouring matters as naphthaline-red, and Martins yellow, and out of these are evolved many others by the aid of other acids. Indeed acids are extracted; notably, phthalic, the lime salt of which by heating is transformed with loss of carbonic acid into a benzoate. Lastly, eosine is obtained, a new red-colouring matter applied to silk, and is a powerful competitor for the position cochineal has hitherto possessed.

After these the next crude product of tar distillation is "anthracene oil." This product, on cooling, forms a sort of thin paste, from which the liquid portion known as "green oil" is separated in the first instance by mere filtration, and ultimately by hydraulic pressure. The mixture of this green oil with the creosote oils, deprived of their carbolic acid and in part usually of their naphthaline, constitutes the creosote of commerce, used for "pickling" railway sleepers and timber generally. The cake of crude anthracene, left by expression of the green oil, is broken up and treated with coal-tar naphtha or with petroleum spirit and again submitted to hydraulic pressure: and the product of so-called washed anthracene is sometimes submitted to sublimation. Lastly, the sublimed or sufficiently washed anthracene is completely purified by crystallisation, at first from naphtha or petroleum spirit, and finally, in some cases, from glacial acetic acid. Anthracene obtained and purified in this way, is the scurce of the madder-dye products alizarine and purpurine, the artificial production of which, originated by Graebe and Liebermann in 1869, although encountered by many difficulties, has now arrived at such an extent and perfection that the cultivation of the madder plant may already be looked upon as a doomed industry.

The development to so large an extent of the manufacture by artificial processes of the most important of all natural dye stuffs, to the exclusion already in a great measure of the natural product, is the most notable triumph of industrial organic chemistry that has ever yet been achieved.

THE NEW GERMAN PATENT LAW.

THE International Patent Laws are of the utmost importance to Practical Science, and although the paper is long, and perhaps in our view rather inconsequential, it is necessary that the Germanic idea and instruction should be recognised and discussed. In that paper there are points of difficulty treated with singular power; points we have not been able to treat better. We see also the assertion of rights on behalf of inventors, declared in a form we ought to imitate. We see also, what is wanted here, an examination of the character and rights of invention, preventing a man of capital from stealing an invention by the means of his wealth from a previous patentee who, poor and weak, friendless and destitute, could not obtain the reward belonging to him. And the regulations in detail, taken entirely, are a most important contribution to the great question of national duties and national obligations as they affect inventors and patentees.

Our description is merely a translation: but it is of permanent value. We therefore, at some sacrifice of space lay it before our readers:—

In the first Section patents are granted for new inventions which admit of industrial use. Excepted are those incompatible with the laws or public morals; inventions of articles of food, for nourishment or luxuries, of medicines and of substances produced by chemical process, so far as the invention does not relate to a certain method of producing such articles.

2. No invention is new if it has already been described, or publicly used in Germany at the time of application.

3. Whosoever first applies for a patent is entitled to the grant. The claim is void if the essential contents of his application have without permission been taken from the descriptions, drawings, models, implements, or arrangements of another person, or from a method of manufacture used by the same, and if such person objects.

4. The patent prohibits the sale or manufacture of the article to which the invention relates. If the invention relates to a method of manufacture, to a machine or other mechanical contrivance, to a tool or other implement, the patent has moreover the effect to prohibit any one from applying such method or of using the article to which the invention relates without permission of the inventor.

5. The patent has no effect against a person who, at the time the patentee made his application, had already been using the invention in Germany, or who had made the necessary preparation for using the same. The patent has no effect in so far as the invention is intended to be used by order of the Imperial Chancellor in the interest of the public welfare. In such a case the patentee is entitled to an adequate compensation by the Empire or the State in whose interest the limitation has been applied for. . . .

7. The duration of a patent is fifteen years, commencing with the day following the day of application. If an invention is an improvement upon another invention patented in favour of the applicant, the latter may apply for a supplementary patent, which expires with the patent for the original invention.

8. At the issue of a patent a fee of 30 marks is to be paid. Except in the case of supplementary patents (paragraph 7), a further fee must be paid for each patent at the commencement of the second and every subsequent year, amounting in the first instance to 50 marks, and increasing by 50 marks per annum for the time of duration of the patent. A patentee who proves his want of means may have a respite in the payment of the fees for the first and second year until the third year, and if the patent expires in the third year, they may be remitted entirely.

9. A patent expires if the patentee resigns the same, or if he fails to pay the fees within three months at the latest after they have become due.

10. A patent shall be annulled if it is found:—(1) That the invention was not patentable according to paragraphs 1 and 2. (2) That the essential contents of the application had, without permission, been taken from the descriptions, drawings, models, implements, or arrangements of another person, or from a method of manufacture used by the same.

11. A patent can be revoked after the expiration of three years:—(1) If the patentee fails to carry out his invention in Germany to a suitable extent, or at least to do everything that is necessary to insure its being carried out. (2) If the grant of license to others for using the invention appears to be demanded in the interest of public welfare, but the patentee, nevertheless, refuses to grant such license upon an adequate compensation and against sufficient security.

12. Any person not residing in the Empire can only advance his claim to the grant of a patent and to the rights resulting therefrom in case of the appointment of a representative resident in Germany. The same is authorised to act in all proceedings by virtue of this law, as well as in civil law suits concerning the patent. In cases of litigation against the patentee, the court in the district of which the representative has his domicile, but if there be no representative, the court of the district in which the Patent-Office has its seat, is clothed with jurisdiction.

SECOND SECTION.—PATENT OFFICE.

13. The granting of patents, the annulment and the revocation of the same is vested in the Patent-office. The Patent-office has its seat in Berlin. It consists of at least three permanent members, including the chairman, and of non-permanent members. The members are appointed by the Emperor; the other officials by the Imperial Chancellor. The permanent members are appointed on nomination by the Federal Council. If they hold an office of the Empire or of a State, the appointment will be for the term of such office, in other cases for life—the appointment of the non-permanent members will be for five years. Of the permanent members at least three must have the qualification for the office of a judge or superior official of the administration; the non-permanent members must be expert in some branch of technical science. The regulations in paragraph 16 of the law of May 31st, 1873, concerning the legal position of imperial officials, does not apply to non-permanent members.

14. The Patent-office consists of several departments. These are formed in advance for at least one year. Any member may hold office in several departments. In case of the granting of a patent, the quorum of any department must not be less than three, among whom there must be two non-permanent members. In the case of decisions regarding the nullity and the revocation of patents, a special department shall be formed. For decisions of this department, a quorum is required of two members including the chairman, who have the qualification for the office of a judge or superior official of the administration, and of three other members. The provisions of the code of civil law with regard to the exclusion or refusal of members of court apply to the members of the Patent-office. Experts who are not members, may be invited to attend at legal proceedings, but they are not entitled to vote.

15. The resolutions and decisions of the departments are issued in the name of the Patent-office; they must be made out in writing with statements of the arguments; and a copy of the same must be delivered officially to each of the interested parties. Notifications by which special terms are fixed will be sent by post in a registered letter against receipt. If a notification cannot be delivered within the country, it will be forwarded by the appointed official of the Patent-office by post, in accordance with the provisions of the paragraphs 161 and 175 of the code of civil law. The decisions of the Patent-office are subject to appeal.

16. If the decision of a department of the Patent-office is made the subject of complaint, such complaint shall be submitted to the decision of another department or of several departments jointly.

17. The organisation of the departments, the regulation of their spheres of duty, the form of procedure, and the order of business of the Patent-office, will be determined by an Imperial order with assent of the Federal Council, in so far as these points are not regulated by the present law.

18. At the request of the Law Courts the Patent-office is bound to give opinion in all questions concerning patents. The Patent-office is in no other case authorised to pass resolutions or to deliver opinions foreign to its legal business sphere without special leave of the Imperial Chancellor.

19. A register will be kept at the Patent-office in which the subject matter and the duration of granted patents will be entered, as well as the name and address of the patentees and of the representatives appointed by them on presentation of their applications. The commencement, the termination, the expiration, the decree of annulment, and the revocation of patents must be entered in this register, and simultaneously published in the *Reichsanzeiger*. Should a change take place in the ownership of a patent, or in the representation of the patentee, such fact will likewise be entered and publicly notified by the *Reichsanzeiger* if brought to the knowledge of the Patent-office in duly testified form. As long as this is omitted, the former patentee and his former representative remain authorised and liable according to the provisions of this law. The inspection

of the register, and of the specifications, drawings, models, and specimens of the basis on which patents have been granted, is open to everybody, unless the patent concerned has been taken out in the name of the Imperial Administration for purposes of the army or navy. The essential parts of specifications and drawings, so far as their inspection is permitted to the public, will be published by the Patent-office in an official paper. Therein will also appear all the notifications which must be published by the *Reichsanzeiger* in accordance with this law.

Third Section.—Proceedings in Patent Matters.

20. The application for the grant of a patent for an invention must be made in writing to the Patent-office. For each invention a separate application is required. The application must contain the petition for the grant of a patent, and must point out in a precise manner the subject matter which is to be patented. In a separate form the invention must be described in such a manner, that thereby the employment of the same by other persons versed in the particular trade to which it relates, appears possible. It shall also be accompanied by the necessary drawings or other representations, models, and samples. The patent-office will issue regulations with regard to other requisites of application. Up to the time of publication of the application it will be permitted to amend or alter the specification. On filing the application a fee of 20 marks must be paid for the cost of the proceeding.

21. Should an application be defective with regard to the prescribed requirements, the Patent-office will point out to the petitioner the defects, and demand of him the amendment within a specified time. Should this demand not be met with in a given period, the application will be rejected.

22. In case the Patent-office considers that the application has been made in due form, and that there is no apparent objection to the granting of a patent, it will order the application to be published. From the date of publication, the subject matter of the application will be provisionally protected in favour of the petitioner, according to paragraphs 4, 5. If the Patent-office is of opinion that the invention cannot be considered as patentable according to paragraphs 1 and 2, the application will be rejected.

23. The *Reichsanzeiger* publishes once the name of the petitioner and the chief points of his claims. At the same time the application and accompanying papers will be laid open at the Patent-office for public inspection, and a notice inserted to the effect that the subject-matter of the application is provisionally protected against unauthorised use. In case the Imperial Administration request a patent for military or naval purposes, the application and accompanying papers will not be subject to public inspection.

24. After expiration of eight weeks from the day of publication —paragraph 23—the Patent-office has to resolve as to granting of the patent. Until that day objections against the granting can be lodged at the Patent-office. They must be made in writing, and be accompanied by arguments which, however, can only be based upon the ground that the invention is not new, or that it comes under the suppositions of paragraph 3, clause 2. Before finally deciding, the Patent-office may summon both parties to attend and be heard; it may also cause the objections to be examined by suitable persons skilled in some branch of technical science, and otherwise institute inquiries for elucidating the matter.

25. Against a decision by which an application is rejected the petitioner may appeal within four weeks after its notification, and against the decision concerning the granting of the patent the petitioner or the opponent may appeal within the same time. On filing the appeal 20 marks must be paid for the cost of the proceedings; should payment not be made the appeal will not be taken into consideration. On the proceeding, paragraph 24, clause 2, is applicable.

26. As soon as the granting of a patent has been definitely decided upon, the Patent-office will cause a notice to that effect to be published in the *Reichsanzeiger*, and then issue a document for the patentee. If a patent is refused this will also be publicly notified. Upon the refusal the provisional protection shall be considered as not having taken effect.

27. Proceedings with regard to annulment or the revocation of a patent will only be instituted upon a motion. In cases provided for by paragraph 10, clause 2, only the injured party shall be entitled to forward such motion. The motion must be directed in writing to the Patent-office, and must contain the facts upon which it is based.

28. After the institution of proceedings has been ordered, the Patent-office will inform the patentee of the motion, and request him to deliver his answer to the same within a term of four weeks. Upon default of the patentee the decision may ensue according to the motion without summoning and hearing the parties, and for such decision all the facts asserted by the mover may be considered as proved.

29. If the patentee lodges his reply in due time, or if, in the case of paragraph 28, clause 2, the motion is not decided upon immediately, the Patent-office will issue the necessary orders for investigating the matter, and, moreover, in the first case communicate the reply to the mover. It may also cause witnesses and experts to be examined. In this respect the regulations of the code of civil law will apply. The depositions must be taken down in writing by a sworn recorder. The decision will be given after the parties interested have been summoned and heard. In case motion is made for the revocation of the patent on the basis of paragraph 11, clause 2, the decision must be preceded by a warning with respect to the revocation of the patent, accompanied by the reasons therefor, and a suitable time shall be fixed after which the revocation may take place.

30. In this decision (paragraphs 28-29) the Patent-office has power to fix the amount of costs to be paid by either of the parties to the suit.

31. It shall be the duty of the Law-courts to render all legal assistance to the Patent-office. Upon special motion they will inflict fines on witnesses and experts who have failed to appear, or who decline to answer or to swear to their depositions; and, moreover, they will cause such witnesses as have not appeared to be brought before the Office.

32. Against the decisions of the Patent-office (paragraphs 28 and 29) an appeal is allowed. Such appeal will be heard by the Imperial Supreme Court of Commerce. It must be presented in writing to the Patent-office, with a statement of the reasons, within six weeks after communication of the decision. In the sentence of the court the costs of the proceedings shall be fixed in accordance with paragraph 30. In all other respects the proceedings in court will be determined by special regulations, to be drawn up by the court, and promulgated by Imperial ordinance, with the assent of the Federal council.

33. Regarding the official language of the Patent-office, the provisions of the law concerning the organisation of the Law-courts, and the language to be used before them, are to be observed. No action will be taken upon applications which are not written in the German language.

Fourth Section.—Fines and Damages.

34. Whoever knowingly makes use of an invention in violation of paragraphs 4 and 5 shall be liable to a fine not exceeding 5000 marks, or imprisonment not exceeding the term of one year, and shall be bound to pay damages to the aggrieved party. Penal proceedings will only be instituted on motion being made to that effect.

35. If judgment is passed in penal proceedings, the aggrieved party will be authorised to publish the judicial decision at the expense of the defendant. The manner of publication, and the time within which the same must be effected, shall be fixed in the decree.

36. Instead of damages to be awarded according to the provisions of this law, the court may, on the request of the aggrieved party, adjudicate, besides the ordinary fine, a payment of compensation not exceeding 10,000 marks. For this amount all defendants shall be jointly liable. Such compensation being adjudicated, all further claims for damages will be excluded.

37. The competency of the Imperial Supreme Court of Commerce regulated by paragraph 12 of the law of June 12th, 1869, concerning the establishment of a supreme court of commercial affairs, shall be extended to such civil lawsuits in which by action a claim is advanced on basis of the provisions of this law.

38. The term within which an action may be brought for an infringement of patent right is limited to three years with regard to any single case by which such action may be supported.

39. The question whether damage has been caused, and to what amount, will be decided by the court according to unbiassed conviction after due consideration of all the circumstances.

40. Sentence will be passed for payment of a fine not exceeding 150 marks or imprisonment: (1) On any person placing on articles, or their packing, any designation calculated to cause the erroneous impression that such articles are protected by a patent in accordance with this law. (2) On any person who in public advertisements, on sign boards, on business cards, or in similar notifications, employs a designation calculated to cause the erroneous impression that the articles thus mentioned are protected by a patent in accordance with this law.

Fifth Section.—Transitory Rules.

41. The patents in force at the present time by virtue of State laws shall remain valid according to the provisions of such

laws until their expiration ; but no prolongation of their term shall be granted.

42. The holder of an existing patent—paragraph 41—may claim the grant of a patent by virtue of this law, for the invention protected by the former. The examination of the invention in such case is subject to the form prescribed by this law. The patent shall be refused if the holder of another patent in force for the same invention—paragraph 41—claims the grant of a patent or raises opposition against the grant before such grant has been decided upon. For want of novelty the granting of the patent shall be refused only in case the invention was not new in the sense of paragraph 2 at the time when first patented in Germany. On the granting of a patent in accordance with this law all patents in force for the same invention (paragraph 41) shall become void if they are in possession of the holder of the new patent. If this is not the case, the new patent will not take legal effect in the district in which the existing patent is valid before the expiration of the latter.

43. The time during which an invention has been protected in Germany by the eldest of the patents in force shall be deducted from the legal period of duration of the patent granted according to paragraph 42. The patentee shall be bound to pay for the remaining term of his patent the legal fees (paragraph 8). The date of payment and annual amount of the fees shall be fixed according to the time at which protection was first granted to the invention in Germany.

44. By the grant of a patent according to paragraph 42, persons who had already been using the invention without infringement of a patent right at the time a patent for the same was applied for, or who had made the necessary preparations for using the same, shall not be precluded in such use.

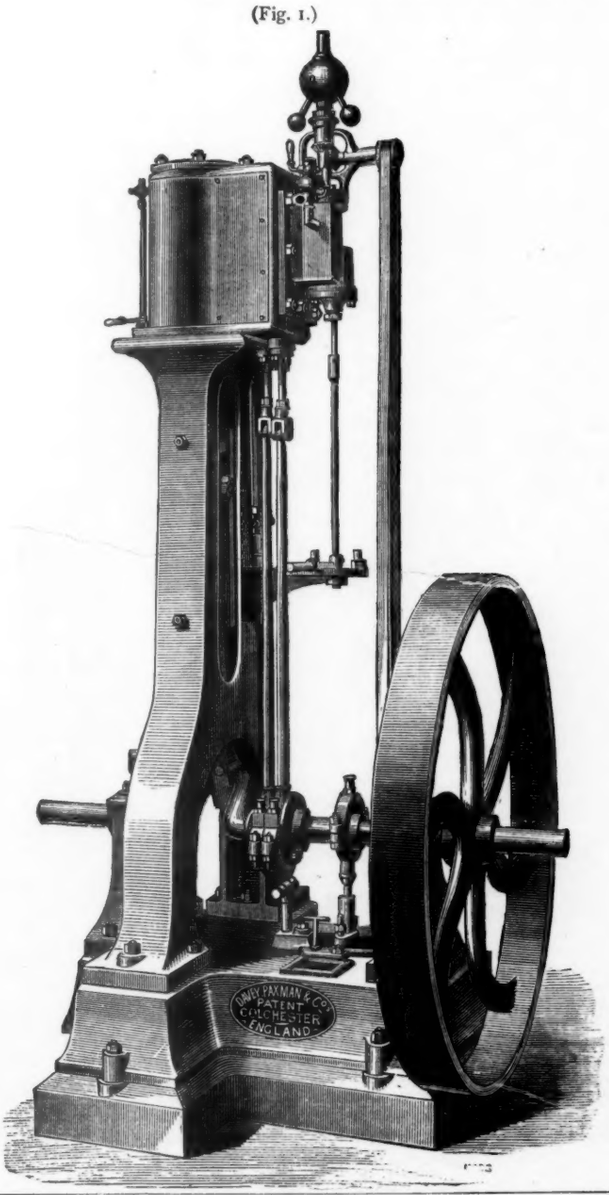
45. This law shall come into force on the 1st of July, 1877.

VERTICAL ENGINES AND BOILERS.

IMPROVEMENTS in the structure of this class of Engine are made continually ; probably they may in some cases be of a class that might be called manufacturers' rather than practical improvements ; but it would appear to be evident that the Messrs. Davey, Paxman, & Co., of Colchester, have, in their latest, overcome a difficulty in a manner entitling them to special mention.

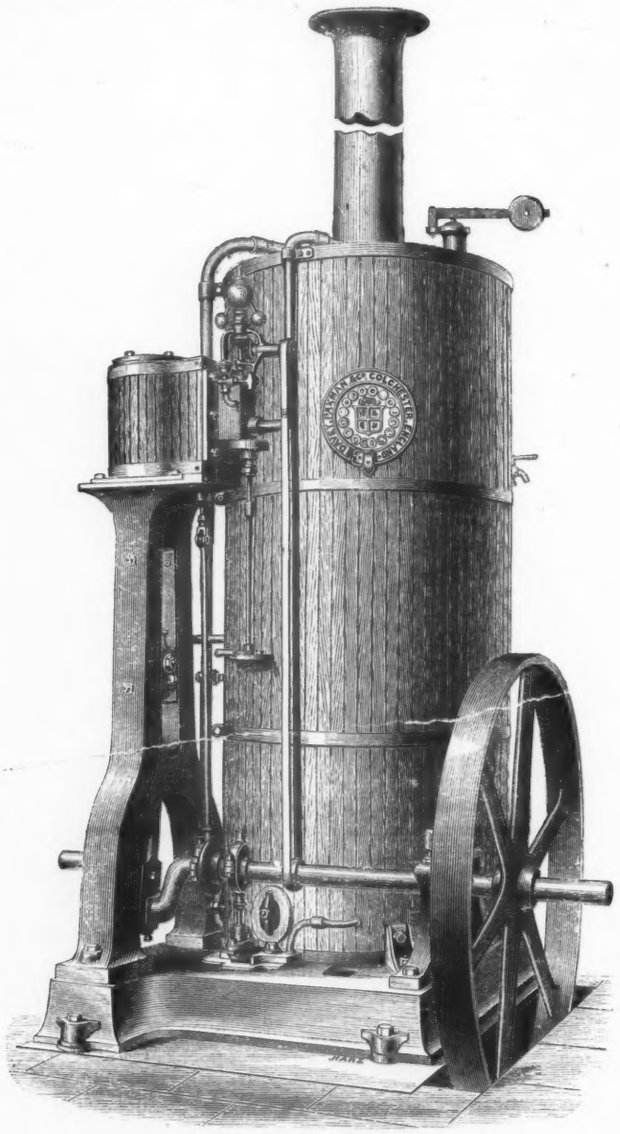
The "Standard Vertical Engine of new type" is a very in-

(Fig. 1.)



clusive specimen, being self-contained on a strong cast-iron bedplate, forming a water tank, to which the pump can readily be attached. The space it occupies is very limited; the parts are reduced to the smallest number, in order to acquire by combination greater control and efficiency, and at the same time place all under the more immediate control of the driver. It is evident that they are very economical and of sufficient strength. The cylinder is lagged with sheet-iron or mahogany, and the crank-shaft, connecting-rods, and, indeed, all the other working parts are all bright and well finished on the best materials. The fly-wheel is turned to receive a driving band, and can be placed at either end of the crank-shaft, while the governors are more carefully finished than usual, and of very simple and compact construction. (Fig. 1.)

Another, combining engine and boiler, is that in fig. 2, and that is a principle of much utility among builders, farmers, and all who require portable steam power. It is built upon a carriage, and therefore is readily transferred from one place to another. It is well known that the first portion of heating surface which the flame encounters is very much more efficient than the last, not only because the temperature it is subjected to is higher, but it is of the nature of all forces to expend themselves. If the draught be quickened the temperature will be increased, and every square foot of heating surface will thereby acquire a greater absorbing power. The hotter the furnace is the more heat will be absorbed by the water in its locality. It increases the efficacy of the heating surface if the smoke is made to strike against the heating surface instead of gliding over it, and hence the preference for vertical tubes with the water within them, upon which the smoke strikes as it passes to the chimney.



(Fig. 2.)

These tubes are further recognised as the best in engines required for the purpose named, in consequence of the facilities they give for the rapid circulation of the water within the boiler; a rapidity of circulation that not only preserves the boiler from any injury by overheating, but by the rapidity of ascent it secures the current, carries off the steam, and presents an ever-new surface to be acted upon; the metal of the tubes is kept cool, and they are in a better condition for absorbing heat from the smoke than if the metal had become over-heated from the steam in contact with it, thereby impeding the supply of water, and preventing rapid absorption.

This engine and boiler of Messrs. Davey and Paxman possesses the advantages of portability, it also contains in its details some other points especially adapting it to the use of

farmers, millers, and builders. It is sold at a less price than such engines generally require, it occupies the least possible room, and it is mounted on a carriage for the purpose of transmission. For these reasons it is commended as ranking among the superior class of that description. Both these machines received the commendation of the judges at the recent Philadelphian Exhibition.

NEEDLES AND PINS.

AVERY curious and enticing speculation it is to investigate the beginnings and progresses of the smaller branches of manufacture that affect human comfort. Curious, because of the difficulty in affixing a date to the origin of those humble indispensable instruments. Enticing, because we are all conscious that a great debt is due to the unknown benefactor. A needle of wood is the origin of our sewing machines ; but see what a great history intervenes. The rudest of humanity learned from necessity that two substances must be combined, or connected, by the ingenuity of a third ; and soon found that such union required the aid of man in its accomplishment. Out of necessity came invention, and out of invention has come in our day a machine surpassing the original, while depending upon and incorporating itself with that foundation. The needle, born of human want, is still the wondrous aid to man ; an aid not to be superseded by any machinery, however grand and glorious that development may become. The wood is not much used, the bone is not much used, iron has taken the place of honour ; and of all the marvels, and of all the utilities which cluster around that wondrous material, the needle is at once the most humble and supreme. Simple, small, and almost of no commercial value, it is the grandest, greatest, and most invaluable of steel products.

Needles, as we have said, are not reckoned in the catalogue of the historian. The Spaniards are supposed to be the originators of the metallic needle, but the art of manufacture came from Germany in or about the year 1565, and was introduced by Krause, who settled in Whitechapel, and made that part of town famous by his Whitechapel Needles. That distinction has been torn away by Redditch and Birmingham ; and now, in the growth of mechanical art, he would be a bold man that dared to affirm the future place of its rest ; the probability is that the manufacture will become common to all the centres of iron industry.

The process of manufacture we need not describe. Wire is cut into lengths and then bundled. The bundle is laid on an iron table, and rollers applied to produce perfect straightness. They are then ground and pointed, which latter operation requires great dexterity. Our object is to illustrate rather the improvements necessary to fulfil the subsequent requirements demanded of the needle by the public or the indiscriminate manufacturer.

These improvements date from 1755, when C. F. Weisenthal invented a needle with two points and an eye in the middle. A curious fancy that did not find acceptance. A much more practical matter was the improvement of the eye of the needle by making it smoother. Cutting it left a roughness very minute, but nevertheless inconvenient, when cotton, silk, or twist were used. Mr. Sheward made a "small steel tool, drill, or rimer" that worked in a lathe upon the eye of the needle, continuing "there so long till the said tool, drill, or rimer hath worked in and about the eye of the needle, so as to take off and smooth all the edges." His experience of fourteen years led him to another advance in 1789. He placed on a revolving shaft a number of discs, alternately smooth and rough, the latter being the largest ; and the shaft rotation took "off all square edges that punches leave in the eye of the needle," and the little wheels burnished or polished the "cheeks and full parts about the head of the needles, and turned them off compleat."

Needles were originally cast in sand, when not made of wire, and in 1795 Mr. Bell suggested the use of moulds. Bodkins, knitting pins, netting needles, mesh pins, and sail needles were produced by his invention. He ordered the artisan "to prepare a suitable metal of 12 to 20 lbs. weight of iron in a crucible : to it add a mixture of charcoal and lime or salt, and stir constantly with an iron rod. Skim the surface of the molten metal, and the iron is refined and fit for casting, and the metal can be tempered in the usual way."

There must have been a fashion in needles, although no one could have so suspected. Mr. Scanbler, in 1812, made a needle with a point extending two-thirds of its length, "in order to obtain a finer point." After they were finished, hardened, and burnished, he dipped them in a solution of gold in acid, to preserve them from rust. Whether the exceeding care for fineness of point could be rewarded after electro-work does not appear.

But the taste for embroidery or ornamenting fabrics by the aid of mechanism, which prevailed here between 1828 and later, brought out rival contrivances. Mr. Bork made a needle with an eye in the middle, and another foreigner did so in 1835. A large number of these needles were placed by elaborate machinery in the desired position, and they followed a pantograph, which, as they travelled, traced the design according to the guidance of the operator ; running through, turning over, coming back again in succession, until the whole work has been performed.

The application of this kind of needle to the manufacture of garments is of recent date, 1848. The *Specification* describes an apparatus with needles, having eyes in the centre and points at each end, also a curved needle, across the bend of which the thread lies in the form of a loop, to be taken hold of by a hooked instrument.

The rapid growth of taste for crochet which occurred in the domestic life of England, about the year 1848, created a demand for the implement which no hand labour could supply; and Mr. Walker invented the manufacture of crochet needles by stamping in dies instead of filing by hand, and added thereto special methods for treating the wire, flattening it, and uniting it to the handle.

Sewing Machines produced another branch in needle-making, and great fear was felt that the old trade would be interfered with to its prejudice. It has not been so. More ordinary needles are made than ever, and they are better. The new interfered not with the old so far as to destroy, and those who instantly caught at a new thing and incorporated it with the old, found their account in the practice. One begins in 1853 to claim as a novelty the triangular point—an idea as old as saddle-making or any other stitching art : another seeks to claim special privileges because he begins by stamping or die-pressing eyes and all—making needles with angular sides or lancet points, or two convex sides, smooth or cutting, which patent, if he had it, could not have borne attack, and so we might go on. Suggestion after suggestion induced inquiry and experiment, and has done good work, although not to the complete satisfaction of every one. In 1853 an inventor offered needles "with spring eyes," or eyes sufficiently long to allow the sides to spring out a little, to admit of a hook and take the thread through. Another modification consisted of making the needle tubular, with a rod or piston working inside of each of them "through a spring." This was really a threading contrivance very ingenious. Then a foreigner invented a needle with flat point and broad ; and in placing it in the machine at 45 degrees angle, for the purpose of having the work more strong and secure. In 1856 Mr. Baylis proposed that the eyes of needles should be elliptical, and that on the body of the needle there should be an inclined groove running into the eye. These impracticable fancies abound. People could invent a thousand things, but neither reason or experience justified any expectations thereon. Bent needles, curved needles, needles made into screws, again and again those with central eyes followed, and we fear the fond hopes that clung around these introductions were crushed soon after conception. Another goes to the expense of inventing a needle with a crook in its length at the back of the eye to form a recess across which the thread is drawn, to form an open space between the body of the needle and the thread, and ensure the entrance of a "looper," an instrument for drawing in the thread.

But occasionally attempts were made to improve the material. Mr. W. Smith did so in 1855. The wire is annealed by drawing it through a furnace. In order to temper it it is conducted as it comes from the furnace, and while in a state of red heat, into a chamber largely charged with oxygen gas.

Many instances might be given of inventions that never reached the honour of being patented. The sanguine found that others had invented, or that the idea was obvious enough to be already largely practised. Embroidering needles are a singular instance of this : one would suppose that as there were at least a dozen sorts of these needles, with eyes in the middle and pointed at both ends, there was not much scope for novelty in form that should excel in utility. These deserve our respect, notwithstanding the inevitable disappointment of their hopes. One of these put himself to preliminary expense to secure an idea of "Finishing the eyes of needles by stringing them on a roughened wire to which an alternating motion was given by mechanical means." The money was lost. No more has been heard thereof.

Ingenuity is manifest in such a case as that of Mr. Bonsfield, who would have improved the sewing needle in 1857, by constructing the needle with an opening to the eye from the side, so that the needle may be threaded at any part of the thread,

or in other words it is not necessary that the point or end of the thread should be passed through the eye. The sides of this opening close together again after the thread has been forced in, and yet the entrance is so formed as not to catch in the work. Again, Mr. Cottrell refers to the kind of needles known as sail-making ones for packing or for glovers, and other similar descriptions, either oval, flat, or triangular, and puts forth an improvement that "consists in grooving or fluting one or more of their sides in the form and after the manner of a bayonet blade." He does not confine himself to any method, but monopolises the idea. Another that died says that his improvement in the eyes of needles consists in "the eye of the needle having an opening at the end or side acting as a V-spring, opening by pressure of the thread, and closing again when that has passed into the eye." Mr. G. H. Berkbeck would form the eyes of needles wedge-like, nearly closing the side of the eye towards the upper end thereof, thereby securely retaining the thread, and preventing it from slipping. Mr. Cottrell made a second attempt in 1861 to improve the large sail-making tools; it consists in making such needles square or four-sided in action, or with five or more sides and angles, except at the head, which will be of the usual form. But inventors were attracted to the eye of theneedle most perseveringly in spite of all repulse. Mr. Disborough would form needles with an additional eye or eyes through which the thread is passed after passing through the ordinary eye, thus the needle is not so liable to become unthreaded. He suggests that such needles might be used to sew with several colours. He adds another item: the same object may be attained by means of an opening at the back of the ordinary eye, into which the thread may be readily drawn and so held. This also came to grief and was never more known. Take another specimen of impracticable ingenuity. Mr. W. P. Hyde announces that his invention consists in forming the eye of a needle by turning over the end and forming a lap-joint through which the thread may be slipped sidewise without the necessity of inserting its end into the eye in the usual way. Mr. Leonard Bennett pays his money to protect his idea of tapering the needle towards the eye as well as towards the point: and Mr. Henry Essex bids the world to know that the object of his invention is to make the sewing needle stiffer and stronger without increasing the amount of material employed. To effect this the body of the needle is made triangular or prismatic in form. The point end is of the usual cylindrical and tapering form, and the eye end of the needle is also round: the prismatic portion being about half its length.

And now we will pause. The subject is in some aspects amusing: it is instructive. There remains the notes on Pins, on Machinery connected with both, and the individual matters, such as cases, packing, &c., which may form another paper.

COAL, ITS ORIGIN AND USES.

MR. A. VERNON HARCOURT gave a lecture to the Society of Arts a few weeks ago, upon this subject in which he has not merely collected such general knowledge as could be obtained by an industrious student, but has added thereto much information that has not yet found its way into the usual channels of instruction on general topics.

We have adapted that lecture to the requirements of our journal by such selections as were suitable, and only by omissions of matters purely appertaining to the locality which could not be of any service for our purpose.

Coal was formed from the air by a process the beginning of which we are all familiar with, through witnessing the growth of vegetation.

Air consists chiefly of oxygen and nitrogen, 78·4 of nitrogen, and 20·6 of oxygen; it contains also small quantities of two or other substances,—namely, water and carbonic acid. Of water, about 1 per cent., and of carbonic acid no more than ·04 per cent. Nevertheless, it is on the presence of these substances in the atmosphere that the growth of vegetation depends.

The plants which grew at the time when our main supplies of coal were formed, differed greatly from the plants on the earth at the present time; very few of those whose forms have been preserved can now be referred by botanists to any existing genera.

Although the acting genera are different, yet we may compare these plants with various existing genera. For example, the *Lepidodendron* appears to be a plant of the same kind as the small club moss, but on a gigantic scale.

Again, there are representatives of the tree ferns and of the conifers. Then there is what seems to have been a large tree, which is called *Sigillaria*, because of the marks, as if impressed by a seal, existing on its stem, and what was formerly supposed to be a separate plant, but has now been proved to be only the root on which the trunk grew. These roots or stools have been preserved more abundantly than the trunks, so that often, where the trunks seems to have entirely disappeared, the roots remain, and as they were supposed to be different, they received the distinct name of *Stigmaria*.

Another variety, which seems to have abounded in the coal measures, corresponds to the Mares Tailis, or *equiseta*, which now grow in marshy places. Some interesting experiments were made several years ago by Professor Lindley, on the powers which different plants possess of resisting decomposition, and he found that out of 177 kinds of plants which he left for two or three years under water, there were only 56 which had not wholly disappeared, and among these were the representatives of those varieties which are found in abundance in the coal measures, rendering it thus probable that the preservation of the forms of these plants may be due rather to their being better able than others to resist the protracted action of water than to their greater abundance.

What may have been the nature and appearance of the forests or jungles which overspread a large portion of the earth's surface, for countless generations of vegetable life, must remain but dimly known. In coal itself the very traces of organic structure are almost wholly obliterated. All that we can say is, that coal consists of the mineralised vegetation of a former period.

As to the way in which it has been accumulated, there were amongst geologists, some years ago, two rival theories. One view was that coal consists of the remnants of plants falling where they had stood, and that by a process of gradual decay, such as is now converting the heather of our moors into peat, these great masses of vegetable matter were accumulated, and made into a more or less homogeneous mass. The interstratification of these deposits with sandstone, limestone, and shale, is supposed to have come to pass in the following manner:—After these plants had grown and died for many generations, the portion of the earth where they grew was flooded, the vegetation was destroyed, and, during the time that it was submerged, mineral matters were deposited where the plants had grown. This submergence, also, we must suppose to have continued for a very long time; then the sea, or more often, it would seem, the fresh water, retiring, plants were again sown, and vegetation again throve for a long period; and thus the cycle of changes repeated itself.

Probably this is the true account of the formation, at any rate, of the greater part of the coal that we have. By this alternate deposition of vegetable and mineral matters would be produced the state of things which an examination of the earth's crust reveals. The stratum of clay seems to have been the soil in which the plants of the coal measures grew. Then there is an accumulation of coal—the vegetable matter stored up; afterwards there was a period of inundation, and of deposition of mineral matters. The thickness of these strata represents in some sorts the length of the periods of time which intervened between each change. Then followed the deposition over it of sand, now compacted to sandstone, for a length of time, and so on, through a long alternation of periods recorded in strata.

The other hypothesis is, that these deposits have been formed chiefly from vegetable matters carried down by rivers. There are examples of such accumulations at the mouths of the Mississippi, and other large rivers, where there are great floods, and quantities of vegetable matter are borne down and deposited in the delta of the rivers.

What seems likely is, that both these causes have been in operation. The extent, and continuity, and even thickness of the seams of coal, and the fact that trees are found standing upright with their roots still bedded in the underclay, make it probable that the former hypothesis represents the principal mode in which coal has been accumulated. But wherever the storage of vegetable matter, and the deposition of great masses of other materials upon it, so that the vegetable matter has become deeply buried in the earth's crust and subjected to a high temperature and great pressure—wherever this has happened, there has occurred the process by which coal is formed.

We have to account for the change which it has undergone. The two principal causes which have concurred in producing this change are pressure and a high temperature. We know that now, as we descend through the earth's crust, the temperature rises at the rate of about 1 degree Fahr. for every 60 feet that we descend. It is to be remembered also, that of the coal which we can now reach, or which comes within the 4,000 feet of depth fixed by the Royal Commission as the greatest depth from which we should ever be likely to succeed in winning coal, much, at any rate, has been at another time at a greater depth beneath the earth's surface than we now find it, and that after-

wards, by disturbances in the crust of the earth, it has been carried up to its present level.

Bischof has inquired into the nature of the changes by which woody fibre may have been converted into coal, and has pointed out that there are various chemical reactions by which this may have been effected. The abstraction of water, carbonic acid, and carburetted hydrogen, or of any two of these, would equally produce an effect which may be described generally as a removal of a portion of the oxygen and hydrogen from the woody fibre —the carbon remaining behind in larger proportion. The principal difference between wood and coal is that oxygen and hydrogen exist in larger proportion in wood, and the change by which coal has been produced has consisted in the more or less complete abstraction of these elements, and of a portion of the carbon in the form of volatile compounds under the influence of heat.

Another change, and one, perhaps, harder to understand, has gone on at the same time. Not only does coal differ from wood in the proportion of its organic constituents, but it differs from it in a remarkable way in its mineral constituents. The ash of coal is a very different thing from the ash of wood. Moreover, the ash of coal is almost the same as the ash of shale, and we must, therefore, suppose further that the coal, or the material of the coal, has been exposed to the action of water carrying mineral matters, either in solution or in suspension for a sufficient length of time for its own mineral ingredients to be washed out; and those which were borne in solution or suspension by the water to have been substituted for them.

Changes are produced in coal by the application of heat. Such changes occurred independently of man's agency, and at a period long before man appeared upon the earth. We know that in several parts of the world it has been observed that inflammable gases issue from the ground. At Chat-Moss, in Lancashire, it was observed long ago that, by simply making a hole in the ground, placing a pipe in the hole, and applying a light, a flame could be maintained for a long time; and actually such gas has been applied to the lighting of buildings. Then, again, not only does nature make gas, but in making gas nature makes coke. Anthracite is natural coke—it is coal which has been exposed to a high temperature, and thus has undergone the same changes which we produce in coal by exposing it to artificial heat.

When coal is heated, the change which it undergoes depends upon the temperature to which it is heated, and also upon the rate at which it is heated. Probably the meaning of this is, not that coal, or any of its ingredients, undergoes different changes, according as it is heated quickly or slowly, but rather that, when it is heated quickly the substances which are first produced by heating it at a lower temperature are exposed to a higher temperature before they can escape. Most likely the effect of heating coal quickly to a high temperature might be perfectly imitated by subjecting the products of its decomposition at a low temperature subsequently to a high temperature. This may be difficult to effect on a manufacturing scale, or may have no economical advantage. In the ordinary process of gas manufacture, each portion of matter undergoes several changes in rapid succession. When coal is treated in the way in which it is treated in a gas retort, and is suddenly exposed to a strong heat, the substances which would be distilled from it if it were first heated gently, come into contact with strongly-heated surfaces, and thus undergo a further change. The difference in the result is, that coal which is gradually heated gives off a much larger proportion of liquid and a smaller proportion of gaseous products, than coal which is suddenly heated strongly.

When the process of heating coal for economical purposes was first introduced, the object in view was not the production of gas, but of liquid and solid products. In 1781, Lord Dundonald took out a patent for the distillation of coal, his object being to produce brown oil, as it was called, naphtha, ammonia, and coke; but the gas was let go. Works for this purpose were in operation for nearly fifty years at Muirkirk, in Ayrshire. Among the coal which was thus treated was found some cannel, which was thought to be unsuitable and thrown away.

The solid residue, when coal has been treated in the retort, is the well-known substance called coke. The same substance, or very nearly the same substance, is also produced in coking-ovens for use in locomotives, and for other purposes. It contains some three-fourths of the total weight of the coal which is distilled; and when the coal employed is a caking coal—that is, a coal which, when it is heated, is sufficiently bituminous to partially fuse, and so aggregate itself together—the coke remains behind in a solid piece. In many respects coke is superior to coal as a fuel. It has the same advantage for many purposes that anthracite or steam-coal has over other coal. For use on board ship, and wherever a clean fire is required, steam coal or smokeless coal is greatly preferred to ordinary bituminous coal.

We do not commonly use coke for fires in our sitting-rooms; but this depends upon the form of grates. A better form has recently been advocated, under the name of Slow Combustion Grates, in which the air is not admitted to the fire from below, but only in the front. The effect of admitting air through an open grating beneath the fire, is to cause the coal to burn quickly away. If air enters from the front, combustion takes place, and each coal glows on the side towards the room. The grate should have a high and wide front, but be shallow from front to back, and have flat bars set edgewise, and rather far apart. The open space above the top bar should be no more than is sufficient for putting on coals. In a grate of this kind coke can be burnt, with the help of a little coal, just as well as coal, and with a better heating effect. The consequence of reform in our grates, will be that this fuel will be largely substituted in domestic use for coal, to the advantage both of the householder and of the gas manufacturer. Now that the price of coal is lower than it has been, the quantity of coke which accumulates at gas-works is very large, and the value of it to the maker is often very much below its real value. The reason we now use the bright or blazing coal in our fires is, that the air being admitted through the bars below, the chief part of the combustion goes on there, radiating heat only upon the hearthstone; and the upper part of the fire, which is what we look upon, would be dull, unless we used a coal yielding a great deal of gas, in order that we may have a blaze at the upper surface and see something bright.

The gases which pass out from the retort consist partly of what are termed permanent gases, and partly of what are distinguished as vapours; that is, of gases which, under other circumstances, would not be gases but liquids: but the distinction is more misleading than serviceable.

However, at the ordinary temperature, a great deal that is gaseous at the high temperature of the gas-retort becomes liquid, and so is collected separately. In one table all the substances, whose names and formulæ are given, consists of combinations of two only of the elements of coal—hydrogen heading the list, and all the other substances being combinations of it with carbon. Those which stand first — hydrogen and marsh gas—are both permanent gases, which have never been liquefied. Others are substances which exist in the gas, and which are also partially condensed with the tar. They are grouped according to their chemical classification, not according to their volatility. Others are liquids. Paraffin is the name generally given to a solid substance that is obtained from coal, and it is given also by chemists to both liquid and gaseous substances which have the same general formulæ, C_nH_{2n+2}. Acetylene, again, is a gaseous hydrocarbon; then follows benzol and its homologues. Naphthalene is sometimes gaseous and sometimes, unfortunately, solid. It is liable to be deposited, and to obstruct gas-pipes at a distance from the works. Anthracene is also a solid substance. Then there are others into which oxygen, nitrogen, and sulphur enter, in combination with carbon, or hydrogen, or both.

The varieties of coal range, shading one into the other, from that containing the largest proportion of carbon — namely, anthacrite—to highly bituminous coals, passing on into cannel coal, and into a substance about which there has been a dispute whether it is coal or not, which is Boghead cannel. The still richer substance, Boghead shale, as it has been called, from its resemblance to Boghead cannel—comes from Australia. These substances differ in appearance from each other; indeed different samples of cannel coal differ very much from one another, some being quite devoid of lustre, and some being brilliant, like anthracite. The more bituminous coals yield a larger proportion of liquid products. Coals are called bituminous, not because they contain bitumen—for this substance cannot be extracted from them—but because they yield it when they are heated. As to the actual substances existing in coal, very little is known, because the actual constituents of coal are extremely insoluble, and chemists have not succeeded, by the application of solvents, in extracting directly (by processes which will produce no change in the coal) substances which they can isolate and examine. Thus it happens that our knowledge is almost entirely of the substances producible from coal by heat, and not of the substances—equally definite, no doubt—which already exist in it.

We will pass now to the other of the two liquid products of the destructive distillation—namely, tar, and will consider the nature of some of the products which have been obtained from it.

Tar is a mixture, in varying proportions, of a great number of different substances When it is heated it is divided into more or less volatile parts. There distils from it, first, some water—indeed, a principal difficulty with the tar distiller is to get rid of the water with which the tar is mechanically mixed.

After that there comes over a substance which the tar distillers calls "liquid naphtha," which is subjected to a subsequent distillation. Next, there comes over a substance of higher boiling point, of a consistency which is almost solid, a buttery substance, called "creosote; and lastly, a substance which is at first more fluid, but afterwards nearly solidifies, called "anthracene oil," because anthracene is obtained from it. That which first distils over has nothing characteristic in its appearance, being a limpid, colourless liquid.

The crude naphtha is first acted upon by soda. It is brought into contact with about one-third of its volume of a strong solution of soda. It contains, besides benzol and other similar hydrocarbons, a quantity of another important substance—namely, carbolic acid. This unites with the soda, and the two together form a heavy liquor, on the top of which the lighter naphtha floats. The liquor is drawn off and mixed with sulphuric acid; it separates, as it cools, into two layers, the lower one consisting of a solution of sulphate of soda, and the upper one of the crude carbolic acid. The tar-distiller carries the operation no further than to run away the sulphate of soda, of which he makes no further use, and to draw off the carbolic acid. The naphtha is next acted on with sulphuric acid, which combines with the organic bases, substances containing nitrogen as well as carbon and hydrogen, and the purified naphtha, now containing only hydrocarbons, is distilled.

In this first distillation the greater part is collected together, and a small quantity remains behind, which is rejected or mixed again with the crude naphtha. It is then what chemists call "fractionally distilled"—that is to say, distilled in a gradual continuous operation; while the runnings of the still are collected separately. The receivers employed are carboys; the order in which they are filled is noted; and, subsequently, an examination of their contents is made, and the liquid products classified accordingly. The examination consists in determining the boiling-point of the liquid. According as the manufacturer wishes to have a hydrocarbon of a higher or lower boiling-point —which depends on the demand in the market—he mixes with the first portions distilled a larger or smaller proportion of the subsequent distillate, so as to have either a larger quantity with a higher boiling-point or a smaller quantity of lower boiling-point. These two are called respectively 90 per cent. benzol and 50 per cent. benzol—meaning a liquid which is judged, from its boiling-point, to contain 90 or 50 per cent. of pure benzol.

Benzol is a hydrocarbon, of which the formula is $C_6 H_6$, and it is associated with other substances—namely, toluol, xylol, cumol, and cymol—substances which are homologous with benzol. These substances form a series proceeding in arithmetical progression by a difference of one atom of carbon and two atoms of hydrogen, the first having the formula $C_6 H_6$, the next $C_7 H_8$, the next $C_8 H_{10}$, and so on. They are all mixed together in the naphtha, and they are, to some extent, separated from one another, in the fractional distillation, by the tar distiller. The purest benzol which is ever collected by the manufacturer contains some admixture of the other substances; benzol, toluol, and xylol. Their appearance is absolutely similar; all are mobile, colourless liquids; but if placed in a flask with a thermometer, and heated until they distilled freely, and observed the temperature, it would be in the three cases, 84, 114, and 126 degrees.

The actual distillates collected at the tar distillery consist of mixtures of these substances boiling at temperatures which differ according as the hydrocarbons of lower or higher boiling-point predominate.

The sample next in volatility to benzol is called "solvent naphtha," the purpose for which it is employed being to dissolve india-rubber. After a time, as the temperature rises, the liquid which comes over is found to be of too high a specific gravity, and unfitted for this purpose; it is called "burning naphtha," and is sold for burning in such lamps as are used sometimes to light stalls in the open air.

The second product of the original distillation—namely, "creosote"—is a pasty mass, which, on standing, divides itself, to some extent into an oil and a solid, the solid being naphthalene. The chief use of this substance is for pickling timber; especially, railway sleepers. The pieces of wood are placed in cylinders from which air is exhausted, and then this substance is let in upon them, and forced into their pores by the atmospheric pressure. The wood is thus rendered more capable of resisting exposure to moisture and the attacks of insects than it otherwise would be.

Some portion of the oil which drains from the semi-solid mass is also used for making lamp-black. It burns with a very luminous fuliginous flame, and the soot which is formed is collected and called lamp-black.

The third product is "anthracene oil." This divides itself into a liquid and a solid. It is poured upon frames carrying a filtering material, and the oil runs through, while the solid remains upon the filter, and is afterwards transferred to bags, where it is allowed to drain, and is then more completely dried and freed from the adhering oil by pressure.

Besides the three distillates, the tar yields a fixed residue called "pitch." This is applied to various purposes, the principal being that of making artificial fuel. It is mixed with breeze, and the pitch serves as a sort of cement to compact together other combustible substances. It is also used for making artificial asphalte, and in preparing a kind of felt.

It has also been supposed that, by the distillation of this substance at a higher temperature, a further quantity of the valuable anthracene might be obtained; but I understand that, although the substance yielded by the destructive distillation of pitch greatly resembles anthracene, there is found to be some difference between them, which renders it not serviceable, as anthracene is. The solid residue of the distillation of pitch is pitch coke—a very pure form of carbon, being almost free from ash, since it is formed by the destructive distillation of a substance which itself has been gaseous.

A few words about the substances formed from these.

One substance directly produced by the destructive distillation of coal is "aniline;" but not in large quantity, and is not easily isolated. Fortunately, benzol, which is produced much more abundantly, contains the same radicle as aniline, and can be transformed into it by a chemical process. It was found, first, that from benzol might be obtained, by the action of nitric acid, a substance of some use in perfumery, called nitro-benzol; and it was also found that by the reduction of this substance—that is to say, the replacement of its oxygen by hydrogen—it was converted into aniline. This reduction was first effected by the action of sulphide of ammonium; but it was afterwards discovered that it was effected equally well, and more economically, by the action of acetic acid and iron. Thus the process consists of two stages, the benzol being first transformed, by the action of a mixture of sulphuric and nitric acids, into nitro-benzol, and then the nitro-benzol being further transformed, by the action of reducing agents, into aniline.

The first great discovery was, that by the action of oxidising substances upon aniline, it was converted into a black powder which was serviceable as a dye. By the action of sulphuric acid and bichromate of potash, aniline was changed into a substance to which the name of "mauve" was given. Subsequently, in the hands of Mr. Perkin and others, this production of colouring matters from aniline received a very great development, and the consequence was the production of a number of brilliant pigments which are familiar to all of us. There is no more striking or more beautiful result of the application of chemistry than that it should be possible, from such a substance as coal tar, to obtain substances at the very opposite end of the scale of mineral being, these exquisite coloured products.

From the anthracene oil, anthracene is obtained; and from anthracene, by a series of processes, a substance known for many years, and used during a much longer period, viz., "alizarin." The investigation of madder, some thirty years ago, showed that the colouring matter consisted principally of alizarin and purpurin, of which alizarin was the more important. Then followed the discovery that, by a succession of operations upon anthracene, it can be transformed into alizarin, the same substance which is the colouring matter of the madder root; so that now actually the use of madder as a dye stuff is almost disappearing, its place being taken by what can be produced to greater advantage economically—namely, the very same material produced from coal tar.

This is the crowning triumph of the application of chemistry to the arts.

THE MANUFACTURE OF GONGS.

METAL Work has received an honour in the labour and fidelity with which Mr. G. W. Yapp has treated that ancient, modern, and universally valued department of human skill, industry, and invention. As a specimen of the method he has adopted, we quote from him the following description of what the Chinese do and how they do it in constructing what may be almost characterised as peculiarly a national product.

"The effect of hammering renders Chinese gongs extremely brittle, a sharp, sudden blow causing them to fly to pieces like glass. The Chinese, therefore, use them with great care near the outer edge, tapping them gently with a padded stick, and cause the vibrations to increase very gradually until their full sound is evolved. When by accident they are broken, the

pieces are collected with great care for the fabrication of new gongs. These pieces are heated to a dull red, and when cooled are easily broken into fragments. The best of these are selected, and being mixed with the metal scraped off the gongs in the manufacture, are melted in common crucibles like those used in England, each crucible containing 7 lbs. or 8 lbs. of the metal, in a special furnace which holds two crucibles. The fuel used is a kind of short-framed coal, something like anthracite in appearance. The combustion is conducted with much care, the coal being placed around the crucibles by means of large tongs through a circular aperture in the furnace; and the heat is maintained by means of a simple blower, which consists of a long rectangular box with a wooden piston and clappers.

When the contents of a crucible are melted, the latter is taken from the furnace and weighed, and as soon as it is emptied it is refilled and replaced in the furnace. The temperature is very high, and it is in the upper part of the furnace that the broken metal is heated to redness, as already stated.

When melted, the metal is well stirred in the crucible before being turned out, the oxide and scum being at the same time carefully removed from the surface. It is then poured out into a mould, which consists of a disc of iron lying on a stone slab, and on which is placed a rim of clay to form the edge of the mould. The whole is then greased with oil obtained from oleaginous peas and sprinkled with fine sand; a conical cover of burnt clay is placed on the moist clay ring, and an orifice at the top of the cone is fitted with a funnel, through which the molten metal is poured. The object of all this arrangement is double; it prevents the metal cooling too rapidly in the mould, and it protects the workmen from the spitting of the metal. When the metal is set, but still red, the cover and the clay are removed, and the cake, which is less than half an inch thick, is well scrubbed with a sort of wooden brush on both sides to remove all impurities.

The first hammering is performed while the gong metal is still red, on a piece of cast iron about 6 inches high and 10 inches to 12 inches in diameter, and mounted on a block of wood. The disc is then beaten with a hammer which has a spherical head, and which, having a long and flexible bamboo handle, allows the workman to strike a hard but not dead blow. Two men are employed in this operation, one wielding the hammer and the other turning the metal disc in such a manner that it is gradually rendered concave. When this first hammering is finished, a disc of 14 inches diameter is raised to 2½ inches to 3 inches; the piece is then carried into another shop, where there is a furnace of about 4 feet in diameter, heated with charcoal, and furnished, like the former, with a blowing-box. A skilled workman, who is seated by the furnace, removes the disc from the latter at the critical moment to an anvil close at hand, and guides it while it is being hammered. On one side is a cistern of cold water, level with the floor of the shop, and on the other is a simple machine on which the disc is clipped round the edge by a cold chisel. While being heated, the workman turns the partly-formed gong round and round and over and over on the mass of incandescent charcoal, so that the metal may be heated thoroughly throughout; and when on the anvil —which, like the former, is a mass of cast iron—it is directed by the chief workman and beaten by five men with hammers and long handles. A peculiarity in the arrangement is that three of the men hammer continually in regular rotation, while the other two wield larger hammers, but beat in unison with the rest. The ability and precision which these men show with their heavy hammers is said to be marvellous. The chief workman stops the operation when the sound of the metal tells him when it is getting cool, places it again in the furnace, and, when sufficiently heated, it is hammered a second time in the same manner. When this is done the gong is nearly of the proper form, and five or six in the same stage of fabrication are then heated together, and afterwards hammered together on the anvil. While this is being performed, all the five strikers aim at the same spot, the fireman turning and directing the work. By this system all the gongs are brought to the same shape and thickness one with the other. But the hammering is continued even after this, the two strikers exchanging their heavy hammers for wooden mallets with flat faces; this hammering is continued for a long time—three-quarters of an hour, says M. Champion, for gongs only 20 inches in diameter. Finally, the gongs are separated, and each one again hammered alone—principally, it would appear, in order to make any corrections in form—and the edges are carefully pared with a cold chisel. At this stage the gongs are very brittle, clippings being easily broken between the fingers; they are therefore heated to dull redness, and plunged for a few seconds in cold water, which is said not to contain any added substances to aid in the tempering.

The gongs are then taken into another shop, where they are scrubbed with a woollen rag and salt water; the water in evaporating leaves a small amount of salt on the metal, and the gong in this condition is again placed in the furnace, turned about in every direction, and again hammered. When the central portion of the gong is finished, the edges alone are heated, in order that any faults may be corrected. During these last operations, in order that the action of the fire may be more regular, and that no heat may be lost unnecessarily, a large sheet-iron cover, suspended to a bamboo handle, is held over the gong while in the fire, and is lifted from time to time to allow the fireman to see and turn the work.

Still the work is not yet completed: the edge of the gong has to be turned up to the proper angle, which operation is described as requiring the greatest ability in the workmen, for a single false blow would cause the metal to crack. The gong is now heated to redness for the last time, and thrown into cold water, where it is left for two or three minutes, when it is taken out and briskly rubbed with a wooden mallet to remove any oxide or foreign matter that may adhere to the surface. The final correction of the edge of the gong is effected by a workman who sits on the ground, and who uses two hammers with short handles, one to strike with and the other as an anvil. When he has completed his work another man takes the gong, places it on an anvil about 8 inches square in the face, and with a round-faced hammer, weighing about 1 lb., with a short handle, passes over the surface, systematically commencing at the centre and proceeding by concentric rings to the outer edge. Sometimes, however, the blows are given in the direction of the radii, but the reason of this is not explained. The blows are vigorous, but the wrist of the workman must be elastic, as it were, so that the shock shall not last too long; but, with all possible care, the work sometimes fails at this point, and should a crack occur, which the workman knows immediately by the sound, the piece is thrown with the waste metal. The traces of this last series of blows are generally apparent in the finished gongs, although before leaving the factory they are scraped with steel tools, either entirely or partially, the scraping being always effected from the centre to the circle indicated.

The composition of these gongs has been found by the analysis of many specimens to be as follows :—

Copper	82·00 parts.
Tin	17·00 „
Iron	1·00 „
Nickel	traces. „

The last-named metal can only be discovered by operating upon several grammes of the alloy.

In the manufactory inspected, the men were, on account of the excessive heat, working only during the night. They were paid fixed sums, and were bound to produce a certain number of gongs; the foreman who had the complete direction of the work received one piastre (about 4s. 6d.) per day, and the workmen half that sum. The whole of them worked all but naked.

At Pekin and other places in the north of China, gongs may sometimes be seen a yard and even more in diameter; but these are rarely seen in the shops; they are said to be made in Cochin-China. A remarkably fine example was shown in the Japanese section of the Paris Exhibition of 1867; it was suspended, as usual, by means of silk-covered cords, and was struck by means of a piece of wood weighing probably 20 lb., which was also suspended with one end opposite the centre of the gong. The sound of this instrument was superb. The reasonance of gongs varies materially, and the Chinese class their tones as male or female; those which have been subjected to the most careful and prolonged hammering produce the male tones.

M. Champion remarks that the Chinese gong-makers have a careless and apathetic air, but the skill, sureness of hand, and vigour which they exhibit in effecting the above long and tedious operations are surprising; their activity and energy is such that it is questionable whether any European workman could conduct such an operation successfully in the same time. The most celebrated place for the production of gongs is Su-tchou, a town remarkable for many manufactures. The work is not carried on during the hottest months, on account of its laborious nature. The tam-tam is a necessary instrument at all marriages, funerals, public and religious fêtes, in short, in all ceremonies, and even on the occasion of visits of the superior mandarins; the demand for them is consequently enormous, and their production gives employment to a large number of men.

And why should it not be so?

All people that on earth rejoice,
Express their praise with glorious voice.
The Monarch waits to hear the sound,
And all his friends obey around.

But why should man refuse to be an element in that harmony?

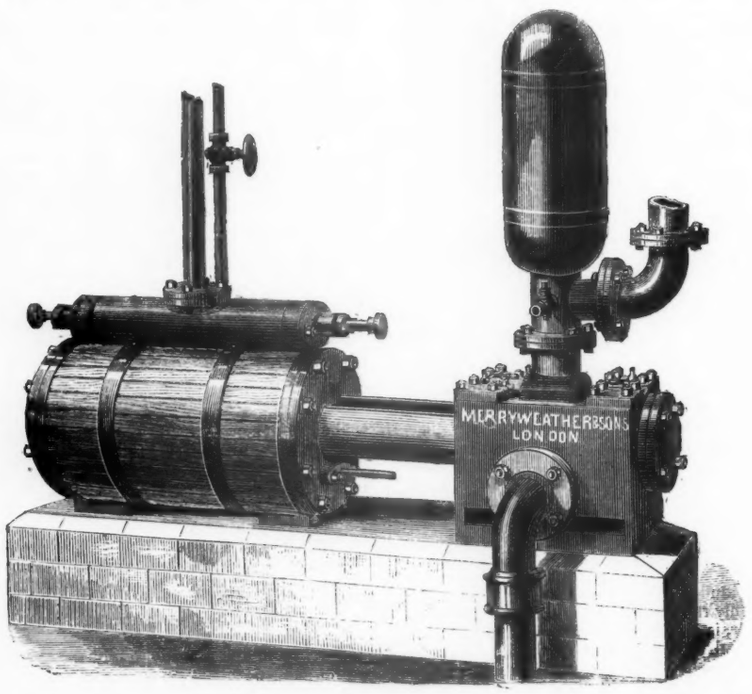
ECONOMY IN FUEL.

THE stern law of commerce and manufacture that enforces frugality as the source of profit is a law that must not be broken. Any infringement brings prompt punishment. You must not waste; if you do you will want. There are advantages and opportunities abounding everywhere, but unless man makes his selection in accordance with reason and circumstance, he will not be able to gain by any inventive faculty he may possess, or any cultured intelligence he may have acquired.

Cost is the basis of profit, for the reduction of cost is the creation to profit. The ever-growing spirit of competition that marks the course of our years compels economy in every way: many trades are actually made profitable only by what they have saved. An envelope maker desires a good return from the sale of the "shavings" and the like, holds good in many other trades or factories. We have to look to machinists for means to effect economy in every direction; economy in regard to time and material is the perpetual study of a good machinist, and especially in the use of costly material that is not convertible, such as coal.

Messrs. Field & Cotton have patented two excellent inventions that will work out a great saving to many persons. They have constructed, or rather Messrs. Merryweather & Co. have constructed from their patent, a coal-saving compound steam pump and a coal-saving compound steam engine, the peculiarity of which can be best described as the instrument for effecting advantages which appeared to be impossible to obtain in a combined form before. We shall make this plain by taking the two items, cost and steam. The economy in working expenses has been so great as can hardly be paralleled. The coal-saving compound steam pump has done for the economy in the use of steam what steam did in superseding manual labour. It works only with half the regular amount of steam, and therefore effectuates a saving of 50 per cent. in the quantity of coal required to drive it.

It is the cheapest and simplest method of obtaining wa er



supply in mansions; and a pair of them can be provided for water works at the same cost as one of the ordinary construction, with no more consumption of fuel. Besides, when two engines are on the premises, the establishment is saved from the disasters consequent on a break down or an accident. It has been found most effective in Sewage and Drainage Works and operations, because the valves are so constructed as to admit of the passing by of solid and heavy substances, and it is so simple in its principle that the ordinary labour can drive it safely. Large, clear openings allow the passage of sand, seaweed, chips; and as the barrel is of gun metal, it is adapted to fresh or salt waters, and makes indeed a good fire-engine.

Our journal is circulated in India and the Colonies, and it is well to point out finally an advantage this engine has in its capacity for adapting Boilers that are especially designed for burning wood, where coal is dear or is not to be had. The inventors have "successfully solved the problem of combining direct action and expansion in the use of steam."

The Coal-Saving Compound Steam-Engine is adapted to the requirements of those who study economy in working expenses rather than the avoidance of outlay in the first cost, and is highly finished. It claims to give out the maximum of work with the minimum of fuel, and is constructed on the well-known compound high and low pressure principle, much improved. For instance, by making the high-pressure cylinder the piston for the low-pressure cylinder, a compactness is obtained not before possible; the long circuitous passages from the one cylinder to the other in ordinary compound engines are avoided, thus effecting a saving of steam with each stroke. Again, by surrounding the high-pressure cylinders with steam, it not only forms a jacket, but heats that part of the low-pressure cylinder into what the steam is expanding, but not that part which is in communication with the condenser; this secures the greatest economy. The working parts are few, and that circumstance makes the engine more durable; and as it is compound, the utmost range of expansion can be used with the smallest variation of pressure upon the crank pin. Its large cylinders, long stroke, and excellence of construction in design, material, and workmanship, erected as it is on a strong neat cast-iron foundation, give it a character that deserves the attention of engineers.

This saving of fuel is one of the most urgent necessities in mechanical operations requiring the use of steam, and the eminent engineers who have given the subject their careful and successful study cannot fail to receive the rewards of commerce and the pleasures of scientific advance: which pleasures are not lessened by the consciousness that, while contributing to the great acquisitions of human experience, they are preserving to Nature the treasure in her gift, and bidding us all to use it economically.

MERRYWEATHER & SONS FIRE ENGINE MANUFACTORY LONDON

CLOTHING AND ITS MATERIALS.

WE offer no apology when submitting to the readers of *The Practical Magazine* the opinion of a learned and retired servant of the Crown on a subject quite within the range of practical science, and much needing the aid of science in many ways :—

"Clothing, a distinguishing characteristic of man, is essentially a result of civilisation, and has borne a relation to its advancement or decline, in quantity, character, and variety. Man, as a wild animal, could doubtless exist with little or no clothing, but such a state would demand continued energy and incessant activity, a condition of life not natural to the human race. And we find, therefore, that as man has become civilised, associated with commerce and society, he has provided himself with sheltering arrangements and put on clothing.

The principal use of clothing is the maintenance of animal heat, whilst its secondary uses will combine protection from external heat, defence from the bite of insects, prevention of the accumulation of dirt, and removal of undue pressure on certain parts, as we see in the use of sandals and shoes. It is fit, however, that the marked distinction between the maintenance and production of warmth should be recollected. Clothing cannot create animal heat. Food, and food alone, is the legitimate source, and clothing merely supplementary. "The best fuel in winter is a well-filled stomach." Sir John Ross truly said, "that starvation from cold follows too soon starvation from food." Being an adjunct to food, it follows that, in colder climates, the warmer we are clad the less necessity for increased fuel, and so we find furs and flannels for our Arctic travellers, whilst we hear from Captain Speke, that the wardrobe of a native African chief frequently consists of an iron bracelet and collar.

Man has adapted substances from both animal and vegetable kingdoms, to make into clothing. Those of animal origin—furs, hair, wool, silk, and leather, being all worse conductors of heat, and so warmer, than the vegetable fibres of cotton, flax, hemp and jute. The raw material should be light, porous, and durable, and a bad conductor of heat. For all these qualities wool certainly claims the first place. Cotton, which is a species of vegetable wool, has, however, but a small share of these properties, for it is exceedingly hard, does not absorb water, nor shrink in washing, and its conducting power is much more rapid than in wool itself. Linen is the coolest and smoothest of all materials used as clothing. It is the presence of air in a substance that makes it a bad conductor of heat, and this you may realise at once by the different sensation experienced on touching wood and iron.

The wool and hair of animals, and the fibres of plants, contain air in their structure, and in direct proportion to its amount, so they vary in their warmth-maintaining power. Dr. Hammond's experiments are very decisive on this point. He found that a vessel of water, temperature 150 deg. Fahr., cooled down to 140 deg. Fahr., if left uncovered, in 5 min. 11 sec. If, however, the vessel were covered with linen shirting, it lost the 10 degrees of heat in 7 min. 24 sec., with cotton shirting in 9 min. 42 sec., with white flannel in 12 min. 35 sec., and with woollen cloth (dark blue), in 14 min. 5 sec.

If we desire to use clothing as a protection from direct solar heat, we have but to attend to colour. Texture has nothing whatever to do with it. In the shade colour has no result, and we obtain our effect from mere thickness of material and conducting power. As far as colour is concerned, white reflects direct heat and light (some of the latter rays being converted into heat rays), and at the same time it radiates much less than black or darker colours. Grey, yellow, pink, blue, and black, follow in order.

It is curious how we have, in our colour of dress, gone directly opposite to nature. Everywhere around us we see white associated with cold, and yet it is in the hottest season that we employ it as a covering for ourselves. May it not be worthy a thought that the radiating power of black and darker colours offers a facility for rapidly throwing off heat generated within. And, again, white clothing would really form the warmest in winter, due regard being paid to power of conduction and thickness of material. The old coachman was right when he stuck to his white duffel coat as the proper thing for winter and summer.

There can be no doubt but that the wearing of dark clothes has arisen simply from principles of economy—the expense of soap and water—and not comfort or use. We must mind our economy does not harm us ; dark clothes get as dirty as light ones, and the fact that we do not notice this, may cause suffering and disease that could be easily avoided.

Woollen articles of clothing have a more vitally important character, they absorb water freely, not only into the fibres (hygroscopic water), but between and amongst the fibres, in the interstices of the material (water of interposition). It is this power that renders wool so superior to cotton and linen.

Professor Parkes has proved that, in comparison to either cotton or linen, the absorbing power of wool, according to relative weight, is double, and according to surface, quadruple.

In condensing the watery vapour constantly given off from the skin of the healthy human body, woollen material restores the latent heat to the system, and is thus always warm. I maintain that its free use is imperative in our alternating and fickle climate. Chills are most fatal conditions, and if they are to be avoided, and a healthy standard of warmth maintained, wool must be worn next the skin. There is but one disadvantage in the use of woollen clothing. It shrinks in washing, and the fibres become smaller, harder, and lose a proportion of their absorbent power. Our manufacturers would do well to battle further with this evil, and by mixtures of wool, or various combinations of silk, cotton, or other material, to produce an article free from the objection, and yet possessed of water-absorbing power. Wool will bear a mixture of 40 to 50 per cent. of cotton, and yet act satisfactorily as a chill-preventing agent.

To the minds of some, the mere mention of woollen garments suggests an overheated and irritable condition. I would impress upon them the fact that wool can be, and is, woven into material of an almost gossamer-like character, as well as into thick mufflers and heavy blankets, and its use can be adapted to all times and seasons.

But it is at night-time that the protective influence of flannel is so valuable. During sleep, the nervous system quiescent, the circulation slow, the senses numbed and at rest, the body is less able to resist changes of temperature, chills, and other evils. Then, flannel clothing is the best guardian of our health and comfort. Further, let me add a word on behalf of babies and young children, who are also unable to resist the external influences of cold. They should always be more warmly clad than adults. The notion that is still held of the possibility of "hardening children," by exposure and cold bathing, cannot too soon be abandoned. It is cruel, wrong, and often fatal. The younger the animal, the less power has it of resisting cold. John Hunter's rules should be written in every nursery. For rearing children healthily, he says there must be "Plenty of sleep, plenty of milk, and plenty of flannel."

May I also hint that low dresses are dangerous luxuries. It is a fact that, within the past few weeks, the powers at the Admiralty have issued orders for the flannels of our seamen "to be cut square across the breast, and close up to the neck, so as to afford more protection to the chest."

How strangely this contrasts with the stringent order for "low dresses" at all her Majesty's drawing-rooms and receptions. It suggests either a sad want of consideration, a disregard of individual health, or the foolish conclusion that ladies are in this respect hardier and more capable of enduring exposure than the weather-beaten tars of the British Navy.

There may be some who look upon my earnest support of woollen clothing with favour, but who regret its extra pecuniary cost. To such I would point out that in common paper—white, brown, or even newspaper—we have an almost equally warmth-sustaining material to wool. For the poor it is invaluable, and can be employed as a lining to a coat or waistcoat, as a blanket or quilt, or even as a petticoat. Ordinary brown paper was our grandmother's "Allcock's Plaster," and right good service it did. Wadding or wool, quilted between two sheets of paper, forms the best and lightest chest protector, and I need not say the cheapest.

An Irishman, talking of his experiences as a sailor in the Arctic Expedition, said, "'Deed, indeed, yer honor, cowld wasn't the name for it. If it hadn't been for my paper blanket, I believe, sir, I'd have died every blessed noight of my life."

One point with reference to the water-absorbing power of articles of clothing requires attention. I rarely see now the large "clothes-horse" in front of the kitchen fire on a Saturday night. As a boy, to have put on clean linen without it had been "well aired," would have been treated as a suicidal act, and been met with prompt punishment. All clothes should be aired. An ordinary shirt, exposed to no unusual circumstances, contains ¾ of an ounce of water, a pair of trousers an ounce, a coat two ounces, and a waistcoat ¼ ounce, and so on in proportion. This necessarily is evaporated by the loss of heat from the body, which is thus more or less reduced. With sick, feeble, or aged persons, with infants and young children, this becomes an im-

portant consideration, and should receive attention at your hands.

I cannot now offer any remarks upon the style of modern clothing. I would only say that having selected the material with a due regard to its properties, it should be worn with more respect to comfort than custom, with more deference to the laws of health than those of fashion.

THE PNEUMATIC RAILWAY.

WHETHER the principle of a Pneumatic Railway will ever be made practicable is a problem that cannot yet be solved. Many doubt the possibility of such a force being rendered sufficiently permanent for such purposes: they contend that every second is an expenditure of force, and that the wear and tear will perpetually increase the average of loss, and produce disappointments. Science may however overcome all these hindrances, for it has deserved many a crown for the successive conquests under most adverse circumstances. Mr. Rammell, of Westminster, is an engineer not likely to submit to fate without a contest, and the idea is one which commends itself in theory.

Some years ago, we are afraid to say how many, we remember the experiment of driving a train by atmospheric pressure between Kingston and Dublin, and upon the early Croydon line. These failed from causes akin to that above named. About 15 years ago, this system was tried in Battersea Park on a small scale. Subsequently an experimental line was made and worked in the Crystal Palace grounds. Then, it will be remembered, the pneumatic despatch line was laid down from Euston to St. Martin's, and it was proposed to make a subway from Scotland Yard to the other side of the river, near Waterloo Terminus. The last two projects have failed, but the failures have had nothing whatever to do with the mechanical principles involved. There is no doubt that Mr. Rammell is right in asserting that mechanical science will warrant the belief that a loaded passenger train can be sent through a tube a mile long with ease and certainty, which surely it would be economically, unless the machinery fails, and that the comfort of the public would be enhanced. But herein is the whole difficulty. It meets the practical man in a form he cannot resist. What can be possible with a model very often absolutely fails in the machine. However, a company is now being formed to construct a pneumatic railway between South Kensington Station of the District Railway and the Albert Hall. The line will rise the whole way to the Albert Hall, the ruling gradient being 1 in 48. The train will be blown through the tube by an ejector, in other words, a great centrifugal pump, 2 ft. in diameter, fixed close to the District station, and worked by a pair of condensing engines exerting about 170 indicated horse-power. The tunnel will be of brick, and the floor will be paved, and, under certain circumstances, it will be opened to the public as a dry, well-lighted foot-way between the Albert Hall and the railway station. Its cross sectional area will be 105·5 square feet; at the end of the train is fixed a screen or piston, with an area of 104 square feet, the difference being allowed for windage. The train will consist of six carriages, of very light build, the rail gauge being 4 ft. This train will hold 200 passengers, and the total load will be 32 tons, or ten tons less than the weight of a single engine on the Metropolitan Railway. The maximum resistance at twenty miles an hour will be about 2,420 lb., requiring to overcome it a pneumatic pressure of 2·6 ounces per square inch, and 162 horse-power, assuming the useful effect to be 60 per cent.

The project deserves our notice from the fact that although £60,000 capital is required, the Metropolitan District Railway have guaranteed a dividend of 4½ per cent, and a board of qualified directors has been formed. The leading engineers moreover give to it their countenance in an address from them to the Commissioners to the Exhibition of 1851, who are the trustees of the ground through which the railway would pass. They say:—"We, the undersigned members of the profession of civil engineers, and others, beg to represent that we have knowledge of the pneumatic system of propulsion, as applied by Mr. Rammell, and of his long devotion to the working out of the invention; that we are cognisant of his plans for a pneumatic railway at South Kensington, the Parliamentary powers for which were granted in 1872, and are of opinion that, apart from the local usefulness of this line, and in view only of the importance of working out practically the principle involved in it, and thoroughly testing its applicability to railway purposes, the undertaking deserves encouragement and support from Her Majesty's Commissioners.—Signed, Charles Hutton Gregory, M. Inst. C.E., W. H. Barlow, James Brunless, T. Hawksley, F. J. Bramwell, John Coode, William Pole, Joseph Whitworth, J. W. Bazalgette, James Abernethy, Edward Woods, George R. Bruce, C. William Siemens, E. Frankland, Harrison Hayter, George Berkeley, J. Frederick Bateman, William Haywood, Latimer Clark, George Robert Stephenson."

THE ARRANGEMENTS AND WORKING OF RAILWAYS IN AMERICA.

RAILWAY arrangements affect, for good or evil, almost every one, and it is necessary that all should endeavour to acquire all the information possible, on a subject most amenable to public opinion when that opinion is intelligent, but most difficult when an unenlightened public have to contend with imperious but intelligent directors. So many facts that are worth noticing and so much of practical knowledge being desirable from these facts lead us to communicate the result of official opinion of an independent kind, such as that of Captain Galton, who visited Philadelphia, on the occasion of the late exposition, and has just published his conclusions.

The relation of the railways to the public involves problems more complex in America than in this country, because the territory is so vast, the corporations are so numerous, the interests of the various districts are so diverse, and each State has its own views of legislation for railways. Moreover, the necessities of the country have required a mode of original construction which entails a large subsequent outlay in order to make the system perfect.

America has no such persons or establishments as those of Chaplin & Horne, or Pickford: houses that can better deal with the complicated diffusive obligations in the transfer of goods than any corporate railway management, at least in so far as the great warehouses are concerned. Nor have they a Railway Clearing House as yet. This is a great disadvantage and has caused much, very much confusion—a confusion that may be truly said to be enormous. Each road, if but 50 yards long, had its own traffic, its own classification of property, its own time-tables, and charged its own rates without regard to through contracts made by other roads. No efforts were made to carry goods through speedily. Bankruptcy of these lines was not unfrequent, and hence a solvent company that happened to be the link between two insolvent neighbours would detain the goods for prepayment of accumulated freight charges due by the insolvent, causing great damage to property: then if the owner complained he was referred hither and thither, and knew not who was to blame or who to be sued. To meet the public wants in this respect several transportation companies were formed in the United States—for instance, the Empire Transportation Company, and that included other methods of carrying than the locomotive. It has had a twelve years' experience of endeavours to promote convenience, promptitude, and safety in the transfer of property between inland points, west of the Philadelphia and Erie Railway, and points on the Atlantic Slope and seaboard and with foreign countries eastward, and consists of ten independent railways, whose discordant interests prevented unity among themselves for business purposes.

It consists of the agents of these companies and their connections, and undertook responsibility as to forwarding goods for rates and for prompt delivery; and it would seem that although an independent corporation, having to acquire its own, the companies are receiving more than when they were ten obstinate rivals. The company finds all the cars: it possesses pipe lines for bringing the oil down from the oil regions to the road or river. It has its stations for goods in New York, ferry boats, oil depots in the oil regions; warehouses, quays, tanks, and stations in many large cities, besides subsidiary agencies for lake traffic that use its own steam-propeller, boats, wharves, and cranes.

The Old Pipe Line is a novelty to us, and illustrates the facility of contrivance possessed by the American people. These pipe lines are used for collecting the oil, and loading it into the cars. The pipe is of wrought iron, lap welded, and of 2 in. diameter, put together with a screw sleeve joint. The main pumping line or lines are run from the centre of production by the most direct rout to the railway station. The pipe is laid along the surface of the ground, except at road crossings, or where protection is necessary. At the railroad large iron receiving tanks are erected of capacity varying from 5,000 to 20,000 barrels each. These are placed at an elevation sufficiently above the railway to allow their contents to be run by gravity through pipes to the loading racks where the cars stand in sid-

ings adjacent to the railway. At the necessary intervals along the pipe line, pumping stations are established, for the reception and forwarding of the oil. The equipment of the main stations consists of a pump house, with two or more powerful pumps worked by steam: two tanks of from 500 to 2,000 barrels' capacity each, in a well-built tank house: a telegraph office, and a dwelling for the telegraphist. From each such station branch connecting lines lead off in every direction to the hundreds of tributary wells, where are accurately-gauged tanks fixed to which the pipe-line branches are attached. Before commencing to draw oil from these tanks their contents are measured and recorded; another measure and record is made after the pipe line ceases taking oil from them, and the difference in inches forms a basis of credit to the well-owner in the company's books. A receipt, called a gauger's ticket, is given to the well-owner at the time the oil is run into the pipe line, and a negotiable certificate for any part of the oil, credited to the well-owner on the books, is given on demand at the pipe company's central office or on telegraphic request.

The average capacity per 24 hours of a single main of two-inch pipe may be considered as about 40,000 gallons. From 1866 to 31st March 1876, the oil passed through the Empire Transportation Company's pipes amounted to 375,810,551 gallons of crude petroleum. The quantity of petroleum held in store in tanks located in the Pennsylvania oil region may be stated as averaging from 80,000,000 to 120,000,000 gallons. In case of the conflagration of an oil tank the loss is shared by the owners, in the ratio of the relative quantities of the oil held for them at the time. From Karns city to the Alleghany Valley Railway the charge made for the use of the pipe line was 30 cents per barrel, an allowance of a little over two per cent. being made for leakage and waste.

As with oil so with grain: the arrangements are of amazing extent. Here is a description of what is called one of this Company's "Elevators" in their station at Erie:—

It is a framed structure 96 feet by 72, enclosed by a brick fire-wall, and is slate-roofed; the main building is 109 feet square, and the tower 124 feet high. Forty-seven separate bins furnish an aggregate storage capacity of 250,000 bushels: and the transfer capacity direct from the lake to the rails is 100,000 bushels every twenty-four hours. The whole is worked by a steam engine. The "elevator" is worked as follows:—A moveable ship-leg, containing an endless five-ply rubber belt, 157 feet long and 17 inches wide, on which 154 metal buckets of nine quarts capacity each are secured, is lowered from the building into the hold of an adjacent grain-loaded vessel; the belt is then started and elevates the grain to the hopper of a 100-bushel receiving scale in the elevator tower, where it is weighed; after weighing, the grain is dropped into an iron receiver below the floor of the building. From this receiver it is raised on another similar bucket belt to a large distributing bin at the top of the house. From this bin the grain is poured into any one of the numbered storage bins, from which it is again spouted (direct into trucks) when ready for shipment by rail. Two railroad trains, accommodating six trucks at a time, are in the building below the storage bins. On each railroad train there is a scale, which is frequently tested by sealed weights and kept in perfect repair. The light weight of each car is taken on entering the building, and the loaded weight as it passes out, the difference giving the weight of the grain. Each lot of grain is kept entirely separate and distinct from every other—no mixing or grading of grain being allowed.

The question of gauge is as perplexing there as it has been here, and the persistency in favour of narrow against broad, is also apparent. Only there is this difference—their narrow gauge is only three feet. Locomotives have therefore to be made of three or four widths according to the fancy of the railway directors. It is very amusing to each of the contending parties to seek to have their own way, and to take care that way shall not be like his neighbour's, but the public suffers seriously. Goods are taken a few hundred miles by a 3-feet gauge railway, and they arrive at a 4 ft. 8½ in.; all has to be unloaded and reloaded, and the cost of the commodity is stupidly enhanced. Had the distance been of one width, the cost would be about 10d. per ton for a given length, but the transfer increases the cost of carriage to 18d., which in an article like corn is simply ruinous. A man sending 200 miles pays the former; his rival, who must use fifty miles of the other line, is mulcted in 8d. per ton.

There are about 8,000 miles of these narrow gauge lines in process of formation; about 3000 are complete. It is said that construction is much cheaper, both as to rail and rolling stock, and it is disputed. It is pretty clear that an engine powerful enough for a 3-feet, can just as well draw the 4 feet 8 inches, and take the same number of carriages or trucks, or as the Americans would say, cars. These cars are 7 feet wide, and allow double seats on one side 36 inches wide, and single on the other 17 inches wide. Each carriage seats thirty-six passengers, *i.e.*, 450 lbs. dead weight for each passenger, and weighs itself about 16,000 lbs.

But these railways have only been in operation for a very limited time, and there is a growing tendency to widen the carriages which, if persisted in, will involve a reconstruction of the line, or they will not pass one another. Then there must follow an increased weight, which is indeed already effected on the broad gauge. It is produced by the necessity of having increased strength to resist the shocks that occur in the course of traffic.

It is said that curves are more readily handled with 3 feet narrow gauge, but the improvements in axles keeps pace, and the opinion of observers indicates that no superiority of that kind can exist on either side.

These narrow gauge railways have been constructed in the United States as economical pioneer lines; and so long as they are retained in that capacity, they may be useful for opening out a country where the traffic is small; but they must be kept in their proper place; and they must not, as they seem to be somewhat inclined to do, copy the frog and the bull in the fable, and attempt to swell out their rolling-stock to do what the 4 ft. 8½ in. gauge can do.

It is quite certain that in districts where the traffic increases and becomes of real importance, it will be necessary that these narrow gauge lines be reconstructed and converted into lines of the 4 ft. 8½ in. gauge, and in such cases the narrow gauge stock will become an incubus; on these grounds, therefore, it would seem preferable to construct light railways on the standard gauge, instead of railways on the narrow or 3 feet gauge.

The working arrangements on some of the railways are very different from those adopted in Great Britain. The pursuit of wealth is keener there than here. Everything gives way to the desire for gold, even character can in many instances be risked if success is assured. The principle of competition for securing economy of working is put in force as far as possible. The manager of a company finds it preferable to keep the several portions of the line distinct in regard to workshops, both for manufacture and repairs, and limited in respect to size to what one superintendent can so look after as to know what work every man is doing. The idea being that thus a comparison can be instituted between the cost and quality of the work at the several shops.

Similarly with the working of the engines. A strict comparison of the cost of running is kept, and published among the men, and a system of premiums is also adopted. The engineer (or what we term engine-driver) on American railways is a person generally of superior education to those on our railways. The engine itself is fitted up with great comfort in regard to seats and protection from the weather. There are guilds or associations to which the engineers belong.

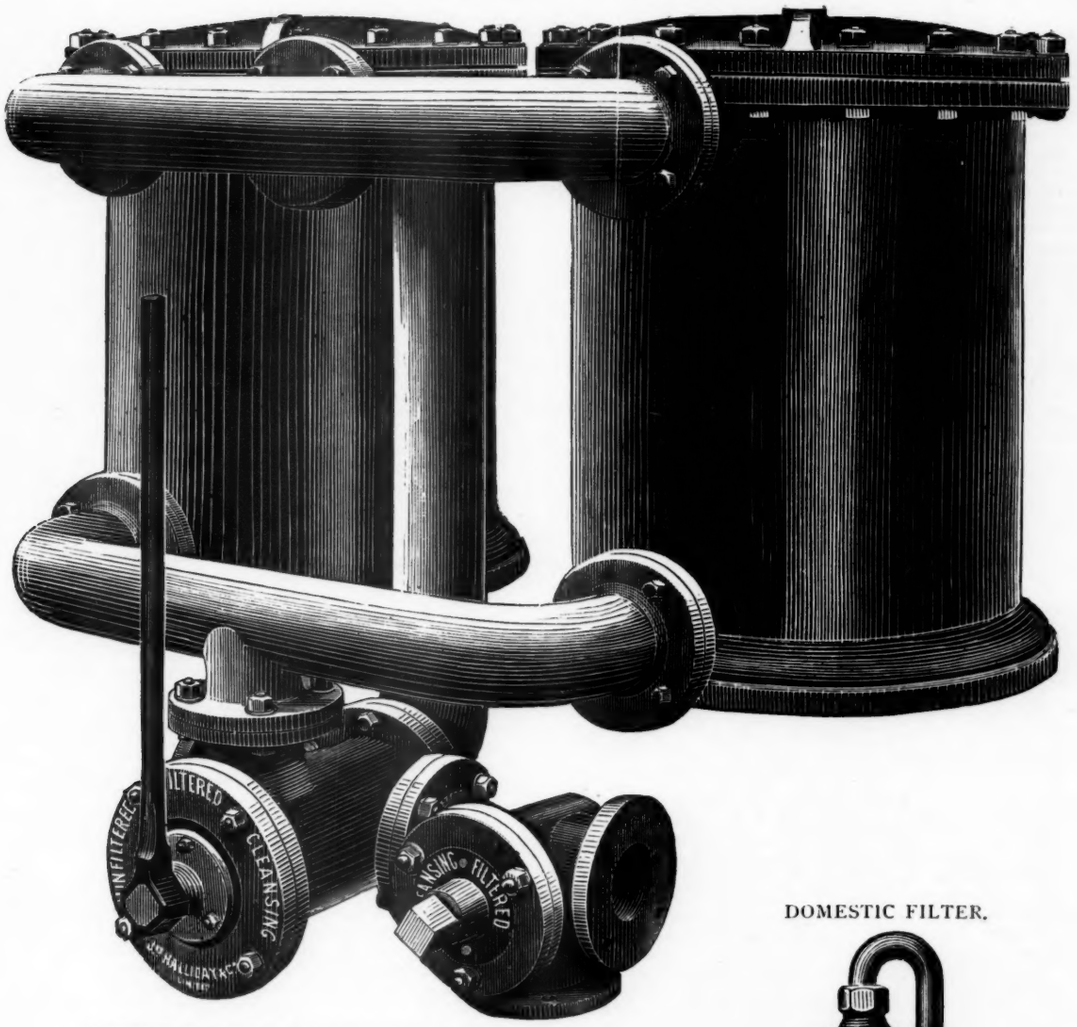
A system of premiums is of course subject to the difficulty that the engineer may occasionally supplement his supply of coal for the cars by taking coal from the trains or from shunting engines. It was stated that this was not found to be a practical inconvenience, as the number of premiums is sufficient to induce each to watch the others closely in that respect; and only one case of such an occurrence was known.

There are monthly first-class premiums of 20 dollars=£4 to the engineer, and 10 dollars=£2 to the fireman; and second-class premiums of 15 dollars=£3 to the engineer, and dollars 7·50=£1 10s to the fireman; and annual first-class premiums of 100 dollars=£20 to the engineer, and 50 dollars=£10 to the fireman; and second-class premiums of 75 dollars=£15 to the engineer, and dollars 37·50=£7 10s to the fireman.

The premium on passenger engines is based on the lowest cost per car hauled one mile; and for freight engines, the lowest cost per loaded car hauled one mile. The results for premiums are taken from the monthly and annual printed reports of the performances of engines. A mileage of 1,500 miles must be made in the month to entitle to monthly premium, and 18,000 miles in the year to entitle to the annual premium. The time kept is not directly brought into account in the table awarding premiums, but it was stated that conduct generally was considered. In calculating the mileage of freight cars, five empty cars are counted as three loaded cars.

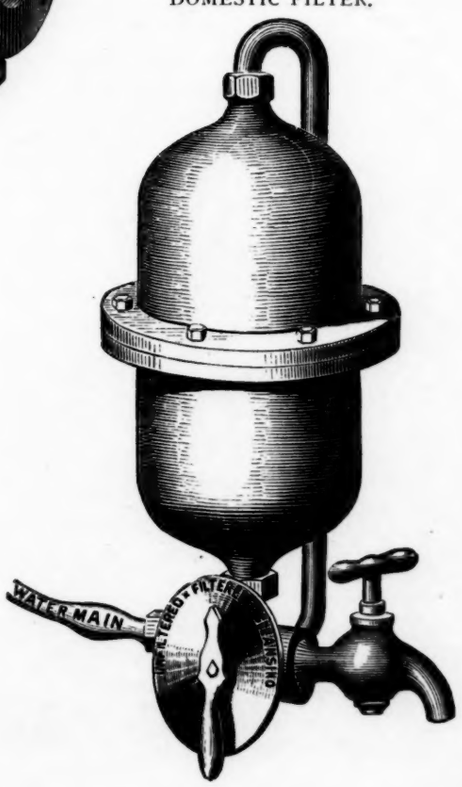
This spirit of competition characterises all classes, and leads to ridiculous conclusions occasionally, sometimes as respects the public, sometimes in regard of the greedy. For fear of a competing railway being made to supply Massachusetts, we believe it was with coal at a reasonable rate of carriage the railway companies bought up the coal mines in the neighbourhood, and then regulated the output and the price, maintaining their old rates of carriage. The result was, the trade of the place fled to a cheaper region, and the railway learnt too late the

FILTER FOR BOILER AND MANUFACTORY PURPOSES.



PATENT HIGH PRESSURE FILTER.

DOMESTIC FILTER.



folly of suicide. In another case, a sharp competition among the five corn-route railways brought the carriage charge to a derisively low condition. The Pennsylvanian Railway Company brought corn from Chicago to Philadelphia at one farthing per ton per mile. The system is to keep the grain where it is grown in the West, and not send it to the coast to fetch the highest price the market will afford. It is paid for on the spot, then put on the rails, and sent direct to the ship for Liverpool. This journey from the West to the port of Liverpool is calculated to take no more than eighteen days. The farmer, moreover, is not anxious to sell corn if he can sell meat. He would rather feed his cattle on the corn, and make more meat for the market than corn, for it is his interest, as he reads it, so to do. The consequence of this must be the development of manufactures in the far West, and the opening up of the coal fields known to be under their feet, only waiting the enterprise which demand will call forth.

The subject of Traffic Rates is not suitable for the purposes of this journal, however interesting it may be to general readers. The comparison of legislation here and there is one that every statesman is bound to make, whatsoever may be his ultimate conclusions or his present opinions. Nor need we touch the subject of Railway Investments. They affect the working, it is true, in many ways, different from our own case, but it is not our province to enter on that kind of controversy.

FILTERS.

NOBODY ought to drink water that has not been exposed to the action of a good filter. This is a doctrine that cannot be called in question, and yet how terribly it is neglected. Half the illnesses are traceable to what really deserves to be termed criminal heedlessness. The makers are many; the demand is great; and there are many varieties to be obtained, each of which claim the precedence of merit and demand the exclusive patronage of the public. We now offer the latest to the consideration of your readers, made from Clemashe & Co.'s patent by Messrs. Halliday, the hydraulic and mechanical engineers, of Newtown, Manchester, and denominated "Patent High-pressure Self-cleansing Filters." Although of recent introduction, there are thirteen in the Manchester Royal Infirmary; they are used at the London Hospital, Mile End, the Stockport Infirmary, the East Lancashire and Prestwich Asylums, the Southport Aquarium, and in about 1000 houses in the town where they are made.

It is not only for human consumption that the use of filters is indispensable; the manufacturer has learned by experience that if he supplies his boiler with dirty water he runs a risk of encrustation. For manufacturing purposes this filter has proved itself invaluable, especially for steam users, for filtering water before entering the boiler. Dirty water can be taken direct from the river or hot-well of a condensing engine, and filtered at once and put into the boiler with the same double-acting force-pump as that used before the filter was adopted. And in some cases where it has been necessary to use large quantities of boiler composition, which composition too often adds to the encrustation it should diminish, or destroys the boiler plates by eating away their material. A good filter ought to make composition unnecessary in many cases. We know that these excel any others that have come within our observation, by keeping the boilers clean three times longer than had hitherto been possible, without incurring any of the risks incident to boilers that are plied with dissolving and consuming compositions.

But the mechanical advantages should be noted. "Its peculiarities are: 1st, That the water passes through under high pressure; 2d, It is air-tight, thus preventing the decomposition of organic matter that the filter might extract from the water, and from which cause many filters are useless as protectors against the creation of poisonous agencies; 3d, It gives a continuous supply; and 4th, By turning the hand on the dial-plate from a point marked Filtered to a point marked Cleansing, the filter can be instantly cleansed.

Manufacturers have been much perplexed by the necessary action of the legislature in the matter of river pollutions, and a wholesale filtering has become the only method by which those who desire to conform to the demands of sanitary laws can be able to do so. Town sewage is another most vexing question. Delusion after delusion have followed each other in rapid succession, and there have been quacks innumerable to add to the irritation. Perhaps it may be found that this, or the adaptation of its principle, will result in a remedial engine of vast municipal and manufacturing value. We add one or two illustrations, and these are self-explanatory.

THE NEWCASTLE CHRONICLE OF PHYSICAL SCIENCE.

JUDGING by a letter from Professor Guthrie which has lately appeared in the *Newcastle Daily Journal*, the managers of the Newcastle College of Physical Science, do not appear to have done much towards improving the condition of their laboratories since the strong recommendations made to them to that effect in the 5th Report of the Royal Commission on Scientific Instruction. Some time since Professor Guthrie, who is one of the Science Examiners at South Kensington, was asked by Professor Herschel, the Director of the Newcastle College, to examine several of his pupils. The examination of the students was, as might have been expected, entirely satisfactory, but the "Preparation Room" and the "Physical Laboratory," were found to be totally unfitted for the purposes for which they were intended. Professor Guthrie, therefore, on returning home wrote a rather sharp letter to the Managers of the College, couched in language, which the Professor styles "frank and forcible," telling them roundly that "The Preparation Room" was a "miserable hole" and the "Physical Laboratory" in the basement was paved with flags and unfit for a "cat with any self-respect to be swung in." This strong language and a great deal more, seems to have put the "Newcastle back up" and no reply was made to Professor Guthrie's letter. Professor Guthrie then appeals to the men of Newcastle to provide funds for building proper laboratories, but he is evidently unaware that they have already contributed upwards of £50,000 to the College, and that they therefore think very justly that having done so much they are, to use the words of the 5th Report of the Royal Commission in a position to establish the claim of the College to assistance from the State." It is, of course, too late to do anything this Session, but the members for Newcastle ought to bring the matter before the House of Commons before another year elapses.

PATENT-OFFICE.

THE Commissioners of Patents have determined to continue their publication of official abridgments from the year 1866 onwards. Most of the series referring to different classes of inventions have now been brought down to that date, and it was originally intended that the work should stop here, the place of these abridgments being taken by the abstracts which, since 1866, the applicants for Letters Patent have been required to send in. As it was found that these abstracts were of little real use, they were stopped about a year ago. The new issue of classified abridgments will contain the inventions of the last ten years, 1867 to 1876 inclusive. Several volumes are already in preparation, but it will be some time before any of them can be published. The Patent-office sale-room has been transferred from Southampton Buildings to Cursitor Street, and considerably increased facilities have been given for the purchase of the official publications. In connection with this alteration, the arrangements for storing the specifications, &c., have been revised, and a new system adopted which enables any required specification to be found with less delay than formerly.

Chemistry applied to the Arts, Manufactures, etc.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

Taranaki Iron.—Specimens of Taranaki pig-iron, smelted in New Zealand, have lately been tested in this country with a view to ascertain their value for making bar iron. The iron produced was of excellent quality, and is capable of bearing a strain greater than that required by the Admiralty for "best best." The great drawback to its use is, that the amount of waste

in working is far greater than would allow the resulting bar or sheet iron to be sold at a remunerative rate. This defect may possibly result from bad smelting. Why do not some of our iron-masters try a few cargoes of the raw material?

Cinchona Growing in Java.—It is now just a quarter of a century since the Cinchona plantations, the first of their kind, by the way, were established in Java. At first they were unsuccessful, owing to the species chosen being unsuitable to the soil and climate of Java. The following figures will show with what success they are at present being carried on. The bark harvest was completed last year at the end of September, and yielded 45,000 kilos. The amount realised in 1876 by the sale of this bark was 111,314 florins, while the total expenses for the year only amounted to 49,857 florins.

Cotton Seed Oil.—The importations of cotton seed for oil-pressing are increasing year by year. Last year the receipts from Egypt alone amounted to nearly 250,000 tons, valued at nearly two millions. Much of the "Fine Lucca" oil, which is sold in the shops, is simply cotton seed oil coloured. It is perfectly wholesome, and in the Southern States of North America hardly anything else is used for frying. If sold under its real name, it would form a cheap substitute for dripping and lard for culinary purposes.

A Good Idea.—Mr. Vogel, writing to the *Times*, makes a valuable suggestion with regard to International Exhibitions, which, if not too late, might be readily adopted for the coming show in Paris. Mr. Vogel's idea is, that after the first exhibition is over, there should be a supplementary exhibition of all the objects that gained prizes. Such a supplementary exhibition would act as an incentive to exhibitors, who would then be sure that their best goods would be examined and appreciated by intelligent people, instead of their being lost in a crowd of inferior articles.

Meteorology in the United States.—The employés of the Meteorological Signal Service have adopted a peculiar code of signals, having found that when simple letters and figures are transmitted mistakes are apt to occur more frequently than is consistent with the accuracy to which they aspire. Thus, "mount, cake, flood, throng," means "Mount Washington, 2nd June, Barometer 30·07, Thermometer 10 deg. F., Wind N.W." By the adoption of this code mistakes have been reduced to a minimum.

Cheaper Petroleum.—If we are to believe Mr. Harman Haupt, an American Engineer well known in the coal regions, petroleum will shortly be brought from Petrolia to the seaboard in iron pipes. The line of pipe will be nearly 400 miles long, and will be four inches in diameter. The cost of laying will be over a million of dollars, and it is estimated that when complete the oil may be transported by pipe from Brady's End to Philadelphia for 16 cents per barrel, whereas by rail it costs 39 cents.—*American Gas Light Journal.*

A New Torpedo Fuze.—It is well known that if powdered metallic antimony be thrown into a jar of dry chlorine the metal bursts into flame. MM. Champion and Pellet have taken advantage of this fact in their invention of a new torpedo fuze of very great sensitiveness. A thin glass ball containing dry chlorine is enveloped in a mass of gun cotton, impregnated with finely powdered antimony. Above the ball is the striker which is kept away from it by a spiral spring and a strong safety screw passing through the side of the tube containing the fuze. The top of the striker which is hemispherial is also protected by a screw cap lined with silverised india rubber to render assurance doubly sure. When used the cap is unscrewed as well as the safety tube, and it will be clear from the description already given that as soon as any thing touches the hemispherial head of the striker its lower end comes in contact with the glass ball, breaks it, whereby the chlorine is liberated, the powdered antimony and gun cotton set on fire, and the explosion of the torpedo determined.—*Moniteur Scientifique, April, 1877.*

Pure Aluminium Salts.—One of the great drawbacks to the use of the sulphate and other salts is their impurity. No matter from what source they are obtained, they always contain more or less iron. M. Ducla has invented a process for obtaining perfectly pure hydrate of aluminium on a commercial scale at a very small additional cost. He treats a solution of crude sulphate of aluminium with a mixture of milk of lime and precipitated chalk. Sulphate of calcium, hydrate of aluminium, and hydrated oxide of iron are precipitated with disengagement of carbonic di-oxide. The triple precipitate is then washed and treated with caustic soda which forms, with the hydrate of aluminium, soluble aluminate of sodium. The solution is decanted off from the sulphate of calcium and oxide of iron. A current of carbonic di-oxide produced in the first stage of the process is passed through the liquid, carbonate of sodium being formed in the solution, and the hydrate of aluminium precipitated. The solution of carbonate of sodium is separated and yields milk of lime, caustic soda for the second, and a mixture of milk of lime and precipitated chalk for the first part of the process being formed. Hence the only expense is for milk of lime—the sodium salt being regenerated—and for the sulphuric acid necessary to form the pure sulphate. Pure acetate of aluminium prepared, dissolving the pure hydrate in dilute acetic acid, may be procured at a much cheaper rate than by the ordinary method in which the lead salt used as a precipitant is lost.—*Comptes Rendus*, No 18, 1877.

Reproduction of Stereotype Plates by Electricity.—A patent has just been granted to one of the editors of the *Evening Bulletin* and the *Morning Call* newspapers of San Francisco for a method of rapid telegraphing of stereotyped plates. It is claimed that by this process an entire page of a newspaper can be transmitted by telegraph in from fifteen to thirty minutes, delivering the copy directly from the instrument in such form that it can be handed immediately to the printers. In other words, the copy will be a substantial reproduction of the original, except that it may be given in a larger-sized letter if so desired. The stereotype plate requires no preparation for the purpose of telegraphic transmission other then the filling of all its depressions, or spaces between the faces of the letters with a non-conducting substance which may be quickly applied, the faces of the type being left clean by means of an equally simple process. The plate thus prepared is placed upon a cylinder arranged to revolve rapidly, so as to present each successive letter in fingers attached to a travelling frame. As the cylinder bearing the plate revolves the frame gradually advances by the operation of a screw; and thus each and every time is successfully presented to the fingers or magnetic points above mentioned. Necessarily the circuit is open when the points are passing over the non-conducting surface; but as often as the metal type presents itself to the said fingers the circuit is closed, and the corresponding magnetic points or pens at the receiving station make the record there in the same letter as the original delineated in a series of fine lines either upon chemically prepared or ordinary paper fixed upon a corresponding cylinder at the receiving station.

Solid Steel Castings.—Mr. Bessemer has long since shown that the "blow-holes" found so frequently in steel castings are due to the formation of bubbles of carbon monoxide. His remedy for these defects was to mix a certain amount of a compound of silicon and iron with the steel. The silicon of the compound united with the oxygen of the carbon monoxide, leaving the carbon behind, and forming minute traces of finely divided silicon dioxide, which in no way acted injuriously on the steel. The free carbon, however, was objectionable if any oxide of iron were present, inasmuch as by reducing this oxide it again formed carbon monoxide, producing blow-holes as before. Mr. Sergius Kern, of the Obouchoff Steel Works at St. Petersburg, has remedied this defect in Mr. Bessemer's process by using a mixed alloy of manganese, iron, silicon, and carbon. The silicon, as before, reduces the carbon monoxide, while the manganese reduces any oxides of iron that may be present; the free carbon, therefore, not being called upon to perform this duty, no carbon monoxide is formed. The tensile power of the steel made by Mr. Kern's process is very great, the breaking weight of one sample being as high as 49·2 tons per square inch. By adding a certain amount of quartz and calcium fluoride to the alloy, Mr. Kern increases the silicon by the formation of a certain amount of calcium silico fluoride, which readily parts with its silicon at a high temperature, the resulting calcium oxide with a certain amount of quartz and manganese forming a liquid slag which floats on the top of the molten alloy. This process gives silicon manganese alloys with greater facility and less expense than when ferra manganese and quartz are used alone.

New Plating Material.—Dr. Kayser has succeeded, without a battery, in coating metals with an alloy resembling German silver, thus giving them a handsome finish and making the surface more durable and permanent than that of tin or silver. He first melts together one part of copper and five of pure tin—preferably the Australian. The alloy is granulated, as usual, but not too fine, and then mixed with water and cream of tartar

—as free from lime as possible—into a paste. To each 200 parts of the granulated alloy is added one part of oxide of nickel, and the articles are laid in it. After boiling a short time they become beautifully plated. Some fresh oxide of nickel must of course be added from time to time. Brass and copper articles can easily be plated in this manner without previous preparation; those of iron must first be copper-plated. By adding some carbonate of nickel to the above bath, or to a common white bath, and boiling, a coating richer in nickel is obtained, and darker, varying in colour from that of platinum to a blue-black, according to the amount of nickel salt added.

Silver and Aluminium.—An alloy of one hundred parts of aluminium and five of silver can be worked like pure aluminium, but it is harder and susceptible of a beautiful polish. An alloy of one hundred parts of silver and five of aluminium is nearly as hard as ordinary silver, but has the advantage of containing no metal of a poisonous nature, or which can effect a discoloration of the silver.

Purified Gutta-Percha.—M. Willmrath gives the following process for purifying commercial gutta-percha:—Dissolve one part of gutta-percha cut up into fine shreds in sixteen parts of carbon disulphide, or benzine. Shake up the resulting solution with coarsely-powdered animal charcoal, and filter. To one part of the solution add four parts of alcohol. Decant the mixture of benzine and alcohol from the resulting magma which must be well squeezed and allowed to dry. It may then be moulded into any form in the usual manner. The benzine may be separated from the remaining mixture by fractional distillation. Gutta-percha prepared by this method is almost perfectly white.

Another New Metal.—While studying several minerals containing metals of the tantalum groups M. R. Hermann, the author, discovered a new metal which he has christened Neptunium. It appears to resemble tantalum, niobium and ilmenium in its chemical properties.

Vegetable Leather.—M. Müntz has found that mushrooms and other fungi are capable of being tanned into a substance resembling leather. It seems that all vegetable tissues and substances which contain nitrogen are capable of uniting with tannin like gelatin on albumen, the quantity absorbed by them being in proportion to the nitrogen they contain. Do not these facts point towards the secret of the famous Japanese paper leather which has so long been a puzzle to our chemists and manufacturers?—*Comptes Rendus*, No 18, 1877.

Improved Railway Lamp.—The Society of Arts have awarded their gold medal, or twenty guineas offered by them to the successful maker of an improved lamp, or means of illumination suitable for railway passenger carriages, which should produce a good, clear, steady, durable, and safe light. It was required to be simple in construction and capable of being readily cleansed. Cost, too, was an important consideration, in judging the merits of any competing system. Lamps were sent in of various constructions, and using various materials, for burning oil, mineral oil, and gas. The committee to whom was entrusted the examination and testing the qualifications of the several articles sent in, made a lengthened and careful examination of them, and, by a process of exhaustion, at last arrived at one which they deemed worthy of a lengthened practical trial, the opportunity for which was afforded to them by the courtesy of the Metropolitan District Railway, who had permitted the erection of the necessary apparatus for trial of the lamp on a portion of their line. The result of that trial fully confirmed the anticipations of the committee, and they unanimously recommended the award of the gold medal to Mr. Pintsch for his system of lighting railway carriages with gas. The gas employed is derived from the distillation of shale oil, and is compressed in cylinders to the extent of six atmospheres, and sufficient gas for a consumption of 35 hours is readily carried, the amount per hour for each light being ·6 of a foot. The cost is less than that of the present oil lamps, and the facility for cleansing is great. The light afforded is soft and diffused, admitting the reading of small print readily in any part of the carriage.

Preserving Vegetables Green.—Two French chemists, MM. A. Guillemare and F. Lecourt, have made a communication to the Paris Academy of Sciences which, besides having great importance from a sanitary point of view, is peculiarly interesting as a scientific application. It is well known that, in consequence of the change of colour caused by the application of heat, sulphate of copper is added to give conserved vegetables and fruits a bright green colour, and it is quite unnecessary to dilate on the danger of such a practice. But the brilliant green appearance is so attractive to the uninformed that some means of retaining it is a commercial desideratum. MM. Guillemare and Lecourt propose the substitution of chlorophyl, the natural colouring substance of leaves, &c., for salts of copper, and they have communicated the results of their experiments during four years to the Academy.

The chlorophyl continuing in a vegetable disappears by boiling all the more rapidly and completely in proportion to its small amount; but vegetables at a heat of about 100 deg. C., brought into contact with soluble chlorophyl, become saturated with it, and when thus saturated, or only half saturated, they retain their colour during cooking.

Those facts having been brought out by experiment, MM. Guillemare and Lecourt proceeded to act upon spinach and other leaves by means of a lye of caustic soda; the liquor thus obtained, treated with common alum, gave a lake of chlorophyl, which was carefully washed to clear it of all traces of sulphate of soda. To render this lake soluble, akaline phosphate and earthy alkalis were used. Thus a soluble compound was obtained of a rather unstable character, containing chlorophyl, alumina, and phosphate of soda. This liquor was added to the water in which the vegetables to be conserved were boiled, when the chlorophyl was taken up by the vegetables more or less completely, according to the duration of the action. The vegetables were then put up in air-tight tins, and cooked in the usual way.

A glass was exhibited, containing peas which had been boiled in pure water as usual, and then raised to 170 deg. C., and kept at that sufficiently long to ensure their preservation; they had lost their chlorophyl. A second was shown, in which were more peas, which had been half saturated with chlorophyl during the boiling, and then cooked in the same way as the preceding; they retained a green colour similar to that given by sulphate of copper. A third glass vessel contained peas which had been completely saturated during boiling, and then cooked in the same way as the others; their colour was more natural than that given by copper, and it was said that they had no taint of astringency in flavour.

The experiments succeeded equally with haricots, cucumbers, plums, &c. The Academy has appointed a commission to inquire into the subject by means of a series of experiments conducted on a large, practical scale.

Waste of Ammonia.—Mr. Gilbert Redgrave, referring to the commercial value of town sewage, proved that in three tons of manure evaporated by heat a revenue of £60 could be obtained at a cost of £20 for coal, by the sale of the manure, phosphoric acid, alkaline salts, and potash. And putting aside theory, he asserted that such a principle was being acted upon in Paris, and brought in a good profit. He had himself seen a factory in Paris where every week ammoniacal liquor was being distilled in a coffee still, and sulphate of ammonia was being made. The sulphuric acid used in the process could be got cheaper here than in France; but it was found there to be a paying process. It might be there was great neglect in not collecting and utilising the urine, for he certainly thought it could be made to pay; and the evaporation of pail stuff, if it could be done without offence, might also be profitable, but not so much so as boiling down pure urine. The manufacturer he spoke of was paying the City of Paris 10 centimes per cubic metre for this weak ammoniacal liquor, and, by making from it sulphate of ammonia, was earning a profit of 25 centimes on every cubic metre. That was apparently very small, but it was sufficient to pay for wear and tear of machinery, and all expenses, and he was quite willing to treat a much larger quantity if he could get it. If, therefore, liquor containing only ·2 per cent. of ammonia could be distilled successfully, other modes of obtaining valuable salts from concentrated excreta hold out still better prospects of success.

French Silver Coin.—It is not generally known that modern French silver coin contains a certain proportion of zinc which gives it the silvery appearance which is wanting in our English shillings and sixpences. Some years ago, M. Peligot, chemist to the Paris mint, showed that an alloy consisting of 8 parts of silver and 12 of zinc was not only superior in colour, malleability, and hardness to the alloy of 835 of silver and 165 of copper then in use, but that it did not discolour even when immersed in a solution of alkaline sulphide. He recommended, that an alloy of 835 of silver and 165 of zinc should be used for the French silver coinage, but custom and red tape were too strong for him. A compromise, however, was effected, and the French 2 franc, 1 franc, 50 centime, and 20 centime

pieces, are now made of an alloy containing 835 parts of silver, 93 of copper, and 72 of zinc. The five franc pieces contain 9 per cent. of silver, instead of only 8.35 per cent., 5.6 per cent. of copper, and 4.4 per cent. of zinc. The same red tapism was shown by the authorities here, when Professor Graham proposed that our bronze coinage should be replaced by the nickel coinage which has been introduced into Germany, Belgium, and the United States, with the greatest success, but the powers that be were evidently afraid that "brass money" would be followed by "Popery" and "wooden shoes," and Professor Graham's proposition was rejected. The alloy in question contains 75 parts of copper, and 25 parts of nickel, and although much harder than our bronze alloy, takes a much sharper impression. The best proportions were arrived at after a large number of experiments by the celebrated Belgium chemist, Professor Stas.

Any improvement in our coinage has been rendered hopeless, since the office of Master of the Mint has been merged in that of Chancellor of the Exchequer; we must content ourselves, therefore, with our dirty, ugly, ponderous pence and halfpence, and dull lead-like halfcrowns and shillings.

Solders.—We extract the following useful receipts for making different kinds of solders from a very valuable little work, the *Annuaire du Chimiste, 1877*, just published by MM. Hachette & Co., King William Street, Charing Cross.

Hard Solder,	No. 1,.....	Copper,	53.3,	Zinc,	43.1,	Tin,	1.3,	Lead,	0.3.
,,	,, ,, 2,.....	,,	44.0,	,,	49.9,	,,	3.3,	,,	1.2.
,,	,, ,, 3,.....	,,	57.4,	,,	28.0,	,,	14.6.		
,,	,, ,, 4,.....	,,	53.3,	,,	46.7.				
Bell Metal Solder,.....		,,	10.0,	Tin,	15.0,	Brass,	20.0.		
Solder for brass,.....		,,	1.5,	Zinc,	6.0,	,,	10.0.		
Silver Solder,.....		,,	23.3,	,,	10.0,	Silver,	66.6.		
Plumber's Solder,.....		Tin,	33.0,	Lead,	66.0.				
Tinman's Solder,.....		,,	50.0,	,,	50.0.				
Gold Solder,	No. 1,.....	Copper,	1.0,	Gold,	5.0.				
,,	,, ,, 2,.....	,,	1.0,	,,	4.0,	Silver,	1.0.		

Hard solder, No. 1, is yellowish and very infusible; No. 2 is lighter in colour and more fusible; No. 3 is white and pretty fusible; and No. 4. is also white but less fusible.

Gold solder, No. 1, is of a deep yellow; No. 2 is much lighter.

Another New Metal.—Mr. Sergius Kern, of St. Petersburg, announces the discovery of a new metal in some platinum residues, which he has named Davyum, in honour of Sir Humphrey Davy. Up to the present time Mr. Kern has only obtained about 4 grains of the new element. It is a white silvery metal, extremely hard, and only fusible in the oxyhydrogen blow-pipe flame. It is to some extent ductile. Its specific gravity is a little higher than that of copper. We must really protest against the nominal system of nomenclature adopted by the discoverers of the last three new metals, gallium, lavœsium, and davyum. As a rule, the method of nomenclature used by chemists for new elements and compounds has been hitherto fairly logical as compared with that used by botanists and mineralogists, who have succeeded in producing much cacophonous compounds, as *Schwenkia*, *Browallioïdes*, and *Schapbachite*. Neither France, Lavoisier, nor Davy can ever gain any more glory by having scarce elements christened after them, after the fashion of retired soap-boilers, who feel it a compliment that their well-paid head gardener should name a new tulip or rose after them or their better halves.

New Tanning Material.—In a paper read before the French Chemical Society M. Jean announces the importation into France of a new tanning material, under the name of quebracho. It arrived in the market under the form of wooden chips, closely resembling mahogany in colour, hardness, and general appearance. Its density is 1.110, and it contains 15.7 per cent. of an astringent principle, closely resembling tannin in its chemical reaction. For leathers in which colour is of secondary importance quebracho ought to form a valuable tanning material.

A New Ink.—In a late number of *Dregher's Polytechnic Journal* M. R. Wagner revives an old suggestion of Bergelins, to use the salts of vanadic acid instead of those of iron for ink-making. In Bergelins' day vaniadum was an exceedingly scarce metal, but to its discovery in tolerably large quantities by Dr. Roscoe, in the new red sandstone of Alderley Edge, its salts are now become commercial products, and are extensively used as mordants in dying aniline and other blacks. Vanadiate of ammonium and tannin give a black fluid capable of great dilution. Vanadic ink is practically indestructible, acids only turn it blue, while chlorine and the alkalies are without action on it.

Amalgamating Solution for Zincs.—Dissolve one part (by weight) of mercury in five parts of nitro-muriatic acid (one part HNO_3 to three parts H. Cl.) heating the solution moderately to quicken the action; and, after complete solution, add another five parts of nitro-muriatic acid. It is best to use but a small quantity of solution at a time. Apply with a brush. Dipping the zincs in large quantities of solution exhausts the latter unnecessarily.

Chatterton's Compound.—

Stockholm Tar, . . .	1 part.	By weight.
Resin, ...	1 ,,	
Gutta-percha, . . .	3 ,,	

Shellac Varnish for Glass.—Put one ounce of the shellac of commerce into a wide-mouthed eight ounce phial, containing five ounces of well rectified naphtha, wood, or spirit. Close the bottle with a cork, and let it stand in a warm place until completely dissolved. Shake the mixture frequently, and pass the fluid through a paper filter; add rectified naphtha to the solution from time to time, in such quantities as will enable it to percolate through the filter. Change the filter when necessary.

Ebonite.—100 parts caoutchouc, 45 sulphur, and 10 gutta-percha.

Insulating Varnish for Paper.—Dissolve one ounce of Canada balsam in two ounces of spirits of turpentine. Put into a bottle, and digest at a gentle heat. Filter before cold.

Varnish for Silk.—Boiled oil, 6 ounces, and 2 ounces of clear spirits of turpentine.

Electrical Cement.—Best sealing-wax.

Amalgam for Electrical Machines.—Tin, 1; zinc, 2; mercury 4. Melt the zinc and tin first, pour into a wooden dish, and add the mercury gradually.

Marine Glue, much used in Batteries.—Dissolve 1 part of india-rubber in 12 parts of brizole, and to this solution add 20 parts of powdered shellac, heating the mixture cautiously over a fire. Apply with a brush.

Solutions for Chemical Paper.—No. 1. Nitrate of ammonia, about 4 lbs.; ferri-cyan. potassium, about 1 oz.; gum tragacanth, 4 oz.; glycerine, 4 oz.; water, 1 gallon.

No. 2. Nitrate ammonia, 2 lbs.; muriate ammonia, 2 lbs.; ferri-cyan. potassium, 1 oz.; water, 1 gallon.

No. 3. Iodide potassium, ½ lb.; bromide, 2 lbs.; dextrine, or starch, 1 oz.; water, distilled, 1 gallon.

No. 4. 150 parts crystallized nitrate ammonia; 5 parts ferro-cyan. potassium; and 100 parts water.

No. 5. 1 part iodide of potassium, and 20 parts starch paste in 40 parts water.

No. 6. Add 2 parts nitrate and 2 of ammonia to a solution of prussiate of potash in water, about 1½ oz. to the gallon.

No. 7. 1 part ferro-cyanide of potassium, saturated solution; 1 part nitrate of ammonia; 1 part of each solution to 20 parts of water.

Of the above, No. 1 may be considered best for shady work on short circuits; being also of comparatively high resistance, it is least affected by leakages from other lines.

No. 2 is much more sensitive, and can be made to record with the faintest trace of current, it is therefore well adapted for long circuits.

No. 3 is highly sensitive, and capable of the most perfect and beautiful work at an extremely high rate of speed.

Cement for Insulators.—Sulphur, lead, plaster of Paris, with a little glue to prevent it setting quickly.

Muirhead's Cement.—3 lbs. Portland cement, 3 lbs. rough sand, 4 lbs. smith's ashes, 4 lbs. resin.

Black Cement.—1 lb. rough sand, 1 lb. smith's ashes, 2 lbs. resin.

Siemen's Cement.—12 lbs. black iron rust or iron filings, 100 lbs. sulphur.

Practical Literature.

TRAMWAYS.[1]

TRAMWAYS preceded steam, and Steam Tram-Cars are now fast increasing on common roads. The capital employed by them in Great Britain exceeds twenty millions, and the returns average more than 5 per cent. dividend. From being a doubtful venture it has become a sound one, and engineering is doing its best to meet all the requirements they evolve. This eighteenpenny book gives a history of the several companies, what have been their difficulties, successes, capital; what their object, and information as to their position on the Stock Exchange and elsewhere. We have in a previous paper referred to the general subject, and shall again, since there have been some notable improvements in their construction. That does not interfere with commending this useful book to those who are interested in locomotion, or who incline to use any surplus capital in that direction.

CHEMIST'S MEMORANDUM-BOOK.[2]

THIS excellent little volume, although primarily intended as a *vade mecum* for the scientific chemist, contains an immense amount of information which should be of interest to every practical man, whether he be engineer or photographer, dyer or manufacturer. It contains no less than 368 tables of different kinds beginning with long measure and ending with the analysis of anthracene. These tables give full and precise data on such widely divergent subjects as the weights and measures of all countries, the coefficients of dilutation of gases, liquids, and solids, specific gravities of almost every substance used in the arts, analysis by the dry and wet ways both gravimetric and volumetric, spectral analysis, the relative solubility of various gases, liquids, and solids in water, assaying ores, gold and silver; useful amalgams and solders, and a host of other information of a like character.

The only fault we can find with the book is that it has no index, a defect which is, however, partially remedied by the truly systematic way in which it is arranged. The print is large and clear, and as far as we have tested it the data given appear to be correct. We have great pleasure in recommending it to our readers, who will find in it a *desideratum* which at present has no parallel in English.

[1] *Tramways Intelligence for 1877. A Short History compiled from Official Sources of the Principal Tramway and Omnibus Companies, with Tables for Investors.* London: Effingham Wilson, Royal Exchange.
[2] *Agenda la Chimiste.* 1877. Paris: Hachette & Cie.

ELECTRO-METALLURGY.[1]

MESSRS. LONGMANS' series of aids to the students of science is excellent. There are, up to the present time, twenty of them on various subjects, and several more are in preparation. Dr. Gore's book is at once elementary and scientific. That is, the student may have capable guidance and the expert a companion. The author has constructed the volume in four divisions—History, Theory, Practice, and Technicals. In the historical portion is a narrative of the origin and development of the science, commencing with the experiments of that wonderful man, Wollaston, and others, and taking us on to the application of those theories to practice by Spencer Jordan and their successors down to the present condition and prospects of Electro-Metallurgy. On the Theory, Dr. Gore ventures to lay down the laws and principles which are necessary to be well known and accepted if the student would have his life grow from a solid beginning and be a well-founded career. The words are not many, but what may be wanting in diffusiveness is compensated for by concise language and emphatic counsel. It is just a digest of what the practical man ought thoroughly to learn as the broad accepted basis; and it leads to the third section—Practice—which begins by giving a description of the general methods adopted by the makers, beginning with the immersion and concluding with the ordinary battery process. "Practical points to be observed" is an enlarged and detailed explanation of the particular means adopted in depositing the various metals: and of course that section is really the book itself. All the metals are discussed—those in ordinary use and those rarely employed—pointing out the probabilities of a greatly enlarged use of the science and the certainty that even in its present state we have not yet seen half the secrets awaiting the effort of human discovery. The concluding section treats of Technicals and supplies hints and instruction in the matter of working in and governing the shops and persons employed, and the best way to keep all the instruments in good working order. It shows the necessity for preserving everything as clean as possible, and in general applies the information of the previous section to the condition and duty of the worker. It is a book much to be commended.

[1] *The Art of Electro Metallurgy.* By Geo. Gore, LL.D., F.R.S. London: Longmans & Co. 1877.